Development and Spread of HIGH-YIELDING VARIETIES OF WHEAT AND RICE in the Less Developed Nations

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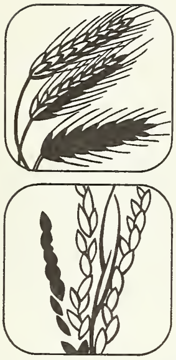
ABSTRACT

The use of high-yielding varieties (HYV's) of wheat and rice has expanded sharply in the developing nations in recent years. This report reviews the development of these varieties and documents their yearly spread in statistical terms. Major emphasis is placed on semi-dwarf (1) wheat varieties developed at the International Maize and Wheat Improvement Center (CIMMYT) in Mexico, and (2) rice varieties developed in the Philippines at the International Rice Research Institute (IRRI).

Data cover the 8-year period from the 1965/66 crop year, when these varieties came into wide use, through 1972/73. As of 1972/73, the HYV wheat and rice area in non-Communist nations, excluding Mexico and Taiwan, totaled about 80.2 million acres (32.5 million hectares). Of this, about 41.6 million acres (16.8 million ha) were wheat and 38.7 million acres (15.7 million ha) were rice. In addition, over a million acres of rice were found in Latin America (excluding Cuba).

Nearly all of the HYV area was in Asia. Within Asia, over half of the HYV area was in India. Altogether, the HYV's accounted for nearly 35 percent of the total wheat area and 19.5 percent of the total rice area in non-Communist Asia. Elsewhere, nearly 2.5 million acres of HYV wheat were planted in North Africa; some HYV rice was beginning to be planted in the remainder of Africa.

KEY WORDS: Wheat, rice, green revolution, high-yielding varieties, seed, research, agricultural development, developing countries.



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PREFACE

This bulletin revises and expands a previous publication, *Imports and Plantings of High-Yielding Varieties of Wheat and Rice in the Less Developed Nations,* issued as FEDR-14 in February 1972 by the U.S. Department of Agriculture (USDA) in cooperation with the U.S. Agency for International Development (AID). Still earlier editions, carrying the same title, were issued in January 1971 and November 1969.

The statistical portion of this edition covers the 8 crop years from 1965/66 through 1972/73. The latter crop year preceded the world fertilizer shortage—the effects of which will not become apparent until the 1973/74 crop year. Data reported are based on information in hand as of April 1974.

The bulletin has been retitled to reflect the gradual change in emphasis which has taken place since it was first issued. Initially, statistics on seed imports were an important component of the study. Over the years, however, relatively more material has been included on the origin and development of the high-yielding varieties (HYV's). Import statistics are still included, but aside from direct exports from Mexico and the Philippines, they are fragmentary.

Compared with the previous edition, this version differs in several respects beyond the updating of statistics. Chapters I and II have been expanded and largely rewritten. In Chapter I, more is said about basic biological characteristics. In Chapter II, a new section has been added on the development of high-yielding Italian wheat varieties. Both the wheat and rice sections have been enlarged to provide considerably more genealogical data on the high-yielding varieties and their offspring. In Chapter IV, new sections have been added on HYV's in Latin America and Africa. Chapter V contains two new tables showing the proportion of total wheat and rice area planted to HYV's over the 8-year period. Finally, Chapter VI has been revised. Throughout, greater use has been made of metric units of measurement.

As in the past, many individuals and organizations have cooperated in compiling the report. Among those of greatest help were USDA agricultural attaches and researchers, AID food and agriculture officers, international agricultural research institute staff members, and FAO (Food and Agriculture Organization of the United Nations) scientists. The extent of their contributions will become evident to those reading the footnotes.

While an attempt has been made to make the report as accurate as possible, some errors have undoubtedly gone undetected. I bear the responsibility.

The funding for both my time and publication costs was provided through the Office of Agriculture, Technical Assistance Bureau, AID.

—Dana G. Dalrymple

CONTENTS

SUMMARY

High-yielding grain varieties are principally defined in terms of their genetic potential and genealogy. Most are semi-dwarfs developed at what is now the International Maize and Wheat Improvement Center (CIMMYT) in Mexico and the International Rice Research Institute (IRRI) in the Philippines. Some, however, are the offspring of varieties developed from similar ancestors in other breeding programs. The most notable is a group of Italian wheat varieties.

Although this report emphasizes varieties popularized since the mid-1960's, the ancestral roots of these varieties are much older. Semi-dwarf wheats were noticed in Japan in 1873. Early in the 20th Century, several of these varieties found their way to Italy where they were used to breed improved varieties which later found wide use. Japanese breeders also crossed their varieties with several American types, ultimately resulting in the release of a Norin variety in 1935. It was brought to the United States in 1946, again crossed with some American varieties, and taken to Mexico in the early 1950's. There the Norin-Brevor cross, in addition to some of Italian varieties, was used by Dr. Norman Borlaug and his associates to develop the well-known Mexican varieties.

Early-maturing rice varieties were known in China as early as 1,000 A.D. The present IRRI varieties appear to have originated, at least in part, in China, Taiwan, and Indonesia. The common ancestor of the current IRRI varieties is Peta, which originated from a cross made between Chinese and Bangladesh varieties in Indonesia in 1941. Another ancestor of four of the IRRI varieties is thought to have gone from China to Taiwan several hundred years ago. The first widely adapted IRRI variety, IR-8, was released in November 1966. The most recent variety, IR-26, was released in November 1973. The newer varieties are being bred for improved resistance to insects and diseases as well as better consumer acceptance.

In focusing on HYV's coming into widespread use since the mid-1960's the report does not cover earlier waves of HYV's. The most obvious is the use of HYV's in Mexico itself; by the late 1950's, over 90 percent of the Mexican wheat area was planted to improved varieties. These early varieties were later replaced by the semi-dwarfs, but we have no statistical record of this process. Much the same is true of Guatemala. Similarly, Taiwan has a long history of improved rice varieties; none is included here.

At the same time, some varieties which are perhaps not in the high-yielding category are included because it has not been possible to sort them out from available statistics. Data for HYV rice in Africa and Latin America are skimpy, but some estimates are included for the latter region for 1972/73.

Summary—HYV Wheat and Rice Area in Non-Communist LDC's in Asia and North Africa

Crop Year	Wheat	Rice	Total
		Hectares	
1965/66	9,300	49,400	58,700
1966/67	651,100	1,034,300	1,685,400
1967/68	4,123,400	2,605,000	6,728,400
1968/69	8,012,700	4,706,000	12,718,700
1969/70	8,845,100	7,848,800	16,693,900
1970/71	11,344,100	10,201,100	21,545,200
1971/72	14,083,600	13,443,400	27,537,000
1972/73 (prelim)	16,815,500[1]	15,658,600	32,474,100
		Acres	
1972/73 (prelim)	41,551,100[1]	38,692,000	80,243,100

[1] Includes Turkey at 1971/72 level.

Nevertheless, even with numerous limitations, the data do show some clear upward trends (see summary table). The area of both wheat and rice has continued to expand at a steady rate. Preliminary data for 1972/73 reveal that the wheat area was 19.4 percent higher than 1971/72, while the rice area was 16.5 percent higher. The HYV wheat area continued slightly larger than the HYV rice area. In addition to the rice figures reported in the summary table, roughly another 429,600 hectares (1,061,400 acres) of rice were planted in Latin America, excluding Cuba (similar data are not available for earlier years). HYV rice is being planted elsewhere in Africa, but detailed area estimates are not yet available.

Nearly all reported HYV area, therefore, is in Asia. If the Latin American rice figures are added to the total, Asia still accounts for about 94 percent of the HYV wheat area and over 98 percent of the HYV rice area. Within Asia, India was by far the leader for both grains, accounting for about 61 percent of the total area of HYV wheat and 55 percent of the total area of HYV rice in Asia and North Africa. In the case of wheat in 1972/73, India was followed by Pakistan and then, at some distance, by Turkey, Algeria, Iraq, and Afghanistan. In the case of rice, the distribution was more even,with India followed by the Philippines, Indonesia, Bangladesh, South Vietnam, and Pakistan.

For Asia as a whole in 1972/73 (excluding Communist nations, Japan, and Israel), the HYV's accounted for about 35 percent of the total wheat area and 20 percent of the total rice area. Among individual nations, the highest HYV proportions were as follows:

—Wheat: Nepal (66 percent), Pakistan (55 percent), India (52 percent), and Lebanon (31 percent).

—Rice: Philippines (56 percent), Pakistan (43 percent), Malaysia (38 percent), South Vietnam (32 percent), and India (25 percent).

Most countries continued to increase the HYV proportions at a steady rate; the main exception was Pakistan, which dropped off in 1972/73.

The rate of HYV adoption may be expected to drop off in some nations as the area suitable for HYV cultivation is used up. Few major nations may be expected to achieve Mexico's nearly complete adoption because of a variety of supply and demand factors.

The Appendix of this report provides a review of rice improvement in three Communist nations: People's Republic of China, North Vietnam, and Cuba.

I. INTRODUCTION

The use of high-yielding varieties (HYV's) of wheat and rice has expanded sharply in the less developed countries (LDC's) in recent years. These varieties, along with critical inputs such as fertilizer and water control, have formed the basis for what is popularly known as the "green revolution." This report will outline the development of these varieties and document the spread in their use.

BACKGROUND AND FOCUS OF THE REPORT

While the green revolution is a recent phenomenon in the LDC's, high-yielding varieties are not new. Crop varieties have been selected for yield performance for many centuries in many countries. A vast number of wheat and rice varieties have probably, over time, been classified as high-yielding.

The distinguishing characteristic of the high-yielding varieties described here is their responsiveness to fertilizer. Added fertilizer is reflected in added crop yields, not vegetative growth of the stems, due to a semi-dwarf or dwarfing genetic characteristic. The varieties are also usually early ripening.

While these biological characteristics are not new (early-ripening rice was known in the People's Republic of China as early as 1000 A.D. and dwarf wheat was grown in Japan in 1873), their combination with fertilizer and a package of management practices that can be, and is, used in the less developed nations is a fairly recent happening.

Accordingly, this report will emphasize what is historically the most recent, and probably the most significant, wave of high-yielding, semi-dwarf varieties. This wave began in the early to mid-1960's and has continued through the present. It originates from two international agricultural research programs—first with wheat in Mexico by Dr. Norman Borlaug and associates (subsequently grouped at the International Maize and Wheat Improvement Center—CIMMYT), and then with rice in the Philippines at the International Rice Research Institute (IRRI).

Chapter II will outline basic facts concerning the origin of the current HYV's, noting genetic interrelations among them. Chapters III, IV, and V will estimate acreages of HYV's planted or harvested in individual countries, by crop years, between 1965/66 and 1972/73 (some preliminary estimates for 1973/74 are also included). Scattered data on seed imports are also included where available. The main focus is non-Communist nations, but rice improvement in three Communist LDC's is outlined in an Appendix.

Clearly there is much other potentially useful statistical information and analysis about the HYV's which is not included in this report. No attempt is made to go beyond area data and to estimate yields and production.[1] Nor is any attempt made to discuss the effects and implications of the high-yielding varieties within the context of the "green revolution" (much literature is available on this subject,[2] including a recent paper by the author[3]). Rather, the purpose of this report is to provide a historical and statistical base for policy analysis and other research.

CHARACTERISTICS AND SOURCES OF DATA

Even though the statistical data focus only on HYV area and seed imports, they are not without definitional complexities. The more general characteristics, problems, and sources of data will be outlined here; more specific details will be found in the footnotes in chapters III and IV.

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[1] Comprehensive yield and production estimates for wheat, based on area data presented in earlier versions of this report, are provided by Sheldon K. Tsu in *High-Yielding Varieties of Wheat in Developing Nations*, U.S. Department of Agriculture, Economic Research Service, ERS-Foreign 322, September 1971, 40 pp.

[2] See, for example: Dana G. Dalrymple, *Technological Change in Agriculture: Effects and Implications for the Developing Nations*, U.S. Department of Agriculture, Foreign Agricultural Service, April 1969, 82 pp.; Clifton R. Wharton Jr., "The Green Revolution: Cornucopia or Pandora's Box?" *Foreign Affairs*, April 1969, pp. 472-473; Joseph W. Willett, *The Impact of New Grain Varieties in Asia,* U.S. Department of Agriculture, Economic Research Service, ERS-Foreign 275, July 1969, 26 pp.; Lester R. Brown, *Seeds of Change*, Praeger, 1970 205 pp.; Walter P. Falcon, "The Green Revolution: Generations of Problems," *American Journal of Agricultural Economics*, December 1970, pp. 698-710; F. F. Hill and Lowell S. Hardin, "Crop Production Successes and Emerging Problems in Developing Countries," in *Some Issues Emerging from Recent Breakthroughs in Food Production* (ed. by K. L. Turk), New York State College of Agriculture, Cornell University, 1971 pp. 3-29; Francine R. Frankel, *India's Green Revolution: Economic Gains and Political Costs*, Princeton University Press, 1971, 232 pp.; Zubeida M. Ahmad, "The Social and Economic Implications of the Green Revolution in Asia," *International Labor Review*, January 1972, pp. 9-34; Randolph Barker, "The Economic Consequences of the Green Revolution in Asia," in *Rice, Science, and Man*, International Rice Research Institute, April 1972, pp. 115-126; Clive Bell, "The Acquisition of Agricultural Technology: Its Determinants and Effects," *The Journal of Development Studies*, October 1972, pp. 123-159; and T. T. Poleman and D. K. Freebaim (eds.), *Food, Population and Employment: The Impact of the Green Revolution*, Praeger 1973, 272 pp. A mammoth study is nearing completion by the United Nations Research Institute for Social Development, Geneva.

[3] Dana G. Dalrymple and William I. Jones, "Evaluating the Green Revolution," presented at the joint meeting of the American Association of Science and the Consejo Nacional de Ciencia y Technologia, Mexico City, June 1973, 86 pp. (Briefly summarized in *Science and Public Affairs*, October 1973, pp. 50-51; to be revised for publication.)

Since the data covers the period from the mid 1960's to the present, countries with large areas planted to improved varieties prior to this time—such as Mexico,[4] Guatemala,[5] Taiwan,[6] and Sri Lanka (formerly Ceylon)[7]—are not covered except for footnote reference. On the other hand, the progeny of some varieties developed during these earlier years may be included.

While the report will emphasize varieties developed at IRRI and CIMMYT, it will also include others, particularly descendents of the IRRI and CIMMYT varieties which have been developed in national programs. Another smaller group consists of previously developed varieties distributed by these centers (IRRI, for instance, provided Taichung Native 1 rice to India in 1964).[8] The wheat section will also include Italian varieties in the Mediterranean region which share some of the same characteristics of the Mexican varieties and appear to be descendents of Japanese varieties.

While the wheat varieties have the *potential* to produce considerably more than local varieties—two to three times as much as local varieties in the case of wheat and up to twice as much in the case of rice—this is seldom fully realized. The reasons generally center about poor water control. lack of fertilizer, and inadequate weed and pest control. Where these problems are critical, the HYV's may produce no more, or even less than, local varieties. The classification, therefore, is on the basis of yield potential, rather than actual output.

Even so, the report will inadvertently include some varieties which might not be considered high-yielding because national data generally are not broken down by specific variety; it is necessary to accept whatever definition of high-yielding varieties was used. The Indian data, for instance, include a locally developed rice, ADT-27.[9] The same is true of the Philippines[10] and several

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[4] Although the proportion of wheat area planted to improved varieties went over 90 percent in 1957, these varieties were not semi-dwarfs; semi-dwarfs were not introduced until 1962. We have no statistics on the annual increment in area planted to the semi-dwarfs. Total Mexican wheat area in recent years has averaged as follows: 1965-69, 1,856,000 acres (751,000 ha); and 1970-73, 1,702,000 acres (689,000 ha). Further details are provided in Chapter II.

[5] Stakman, *et al.*, writing in the mid-1960's, stated that ". . . for more than a decade the entire acreage of wheat in Guatemala has been sown to Mexican-bred varieties." These varieties were also used in Colombia and Chile. For details, see E. C. Stakman, Richard Bradfield, and P. C. Mangelsdorf, *Campaigns Against Hunger*, Belknap Press of Harvard University Press, 1967, pp. 268-272 (quote from p. 268).

[6] The Japanese initiated rice breeding work in Taiwan early in the century. Further details will be provided in Chapter II.

[7] The leading local variety is H-4, which was developed in the early 1950's.

[8] B. P. Pal, "Modern Rice Research in India and Its Impact," *Rice, Science, and Man*, IRRI, 1972, p. 92.

[9] ADT-27 was the best known product of a joint program conducted by the Indian Council of Agricultural Research and the Food and Agriculture Organization. The Mahsuri variety was developed at the same time in Malaysia. (For background, see Gove Hambidge, *The Story of FAO*, Van Nostrand, 1955, pp. 145-148.)

[10] The BPI series (which includes BPI-76) was developed by the Bureau of Plant Industry of the Philippine Government.

other countries. Where the exact varietal composition is known, it is presented in a footnote.

The data cover only commercial plantings; no attempt has been made to summarize the area planted for research purposes. Thus, many countries other than those listed may have HYV's under test . . . and may even have moved into commercial production.

DATA SOURCES

Data on area and seed imports generally come from different sources. Most are unpublished. They apply, as far as possible, to July-to-June crop year plantings, although harvested area is reported in a few cases, and is so noted.[11]

The area information is largely based on reports submitted by AID country missions or U.S. agricultural attaches. These data, in turn, were usually obtained from official reports or estimates by the countries themselves. The national systems for collecting this information may not, in many cases, be very advanced. While the data have been checked as far as possible, there is really no good way of knowing how accurate they are. Therefore, they should be regarded as only approximate.[12]

The seed figures are believed to be relatively accurate, but quite incomplete except for unusually large shipments from Mexico and the Philippines. Virtually all of the statistics on Philippine rice exports were provided by IRRI.

SOME BASIC BIOLOGICAL CHARACTERISTICS

The basic biological characteristic of the high-yielding varieties is their responsiveness to fertilizer. This feature is made possible by their dwarf or semi-dwarf growth habit. But some other biological features are also important, two of the most significant being growing season and relationship to water supply.

Rices are of two major types—indica and japonica. Knowledge of the characteristics of each type is helpful in understanding breeding efforts described in Chapter II.

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[11] This process is not very precise and is subject to error, particularly where crop seasons, such as the aus (spring-summer) rice crop in Bangladesh, cut across the above time period. The assignment of some crops to specific crop years may, therefore, be open to question.

[12] The harvesting period follows the planting date by at least 3 months, creating further difficulties in making a consistent classification by crop years.

It is also useful to recognize that wheat is basically a temperate and semi-tropical crop, while various types of rices may be grown in regions ranging from the warmer temperate zones to the tropics. In each case, the normal range can be extended somewhat by breeding efforts and cultural practices.

GROWING SEASONS

Both the Mexican-type wheats and IRRI-type rices have some flexibility with respect to planting date in the developing nations. That is, they may be grown in the dry winter season and wet summer season. There are, however, some differences between the two crops.

Wheat. Wheat is basically of two types, winter and spring. Botanically, the Mexican varieties are spring wheats (i.e., planted in the spring and harvested in late summer). Where winters are mild, spring wheats may, like winter wheats, be planted in the fall and harvested in the spring. This practice is enhanced by the photoperiod insensitive nature of the Mexican wheats. The winter culture of spring wheats is generally utilized in the less developed nations in warm regions.[13] In some regions where there is a heavy summer monsoon, culture of Mexican varieties may be largely limited to the winter season.

Rice. The wet summer season is the traditional period for rice culture. Where irrigation or sufficient rainfall is available in tropical areas, rice may also be grown during the winter months. In fact, in many areas, the IRRI-type rices are more responsive to nitrogen fertilizers and produce higher yields during the dry winter months when high solar radiation prevails.[14] Significant quantities of the HYV's are planted during this period in some countries.[15] In addition, the photoperiod insensitivity of the HYV's usually shortens their growing period.[16] This, in turn, may facilitate multiple cropping.[17]

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[13] In Turkey, it is possible to plant Mexican varieties during the winter in the southern coastal areas, but it is necessary to use winter wheat varieties in the cold, dry Anatolian Plateau.

[14] T. T. Chang, "The Genetic Basis of Wide Adaptability and Yielding Ability of Rice Varieties in the Tropics," *International Rice Commission Newsletter*, 1967 (Vol. 16, No. 4), pp. 4-12. Most LDC's have low potential photosynthesis values in the wet summer months because of cloud cover; this is one reason why summer rice yields are relatively low in many LDC's (Jen-Ju Chang, "Potential Photosynthesis and Crop Productivity," *Annals of the Association of American Geographers*, March 1970, p. 98).

[15] During the 1972/73 season, the following proportions of HYV area were planted in the winter: Bangladesh, 42 percent; Indonesia, 33 percent; Ceylon, 53 percent; and Thailand, 57 percent (based on footnotes to country tables in Chapter IV).

[16] The extent to which this is true depends on the specific variety, location, and crop season. In the more heavily planted areas of Asia, the improved varieties mature in 125 and 135 days during the wet season, some 5 to 60 days sooner than traditional varieties (Palman 579 matures in 115 days in the Punjab state of India). There are a few exceptions associated with low temperatures and long days; during the aus (summer) season in Bangladesh, for example, some indigenous varieties may mature faster than

RELATION TO IRRIGATION[18]

High-yielding types of both wheat and rice tend to be raised under irrigated conditions. Since the high-yield potential of the varieties is achieved by applying inputs such as fertilizer, an added cost is involved. When water control—both supply and drainage—is inadequate or unreliable, the added risk discourages the use of these and other inputs, and thus reduces or eliminates the advantage of the varieties.

Both the quality of irrigation systems and the need for irrigation vary widely in the developing nations. Irrigation systems range from virtually complete year-round supply to occasional supplementation of rainfall. Most commonly, the systems supplement rainfall during the wet season and service only a limited area during the dry season. High-yielding varieties do not require more water than local varieties in a physiological sense; in fact, because of higher yields and shorter growing periods, they may actually use less per unit of product. But, as noted above, the attainment of the full potential of the HYV's without undue risk requires an assured water supply. This increases the demand for water.[19]

Wheat and rice water requirements vary sharply. Rice, which is largely grown under flooded or paddy conditions, requires much more water per unit of land than wheat—over three times as much under some Indian conditions.[20] Thus, rice is most often raised in monsoon areas and wheat in the drier climates. Similarly, rice is more often grown during the wet season and wheat during the dry season. In some instances, where growing seasons permit, they are able to follow each other in multiple cropping rotations.[21]

Wheat. About 2/3 of the high-yielding wheat varieties are raised under irrigated conditions, principally in India and Pakistan.[22] Some important regions, however, such as north Africa and the barani (rainfed) area of Pakistan, receive little, if any, irrigation.[23] Even without irrigation, yields of

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IR-8 or IR-20. (Letter from T. T. Chang, IRRI, October 25, 1973; for details see Chang and B. S. Vergara, "Ecological and Genetic Aspects of Photoperiod-sensitivity and Thermo-sensitivity in Relation to the Regional Adaptability of Rice Varieties," *International Rice Commission Newsletter,* June 1971.)

[17] Weather and water supply permitting. The same may be true of wheat. For more information on multiple cropping, see Dana G. Dalrymple, *Survey of Multiple Cropping in Less Developed Nations*, Economic Research Service, U.S. Department of Agriculture (in cooperation with AID), FAER No. 91, October 1971, 108 pp.

[18] Drs. Randolph Barker and T. T. Chang of IRRI were of help in preparing this section.

[19] In economic parlance, the HYV's may raise the marginal value product (mvp) of water. This increase, however, may be of little practical value where added irrigation water is not available, as is often the case in canal irrigated regions. On the other hand, the higher mvp may stimulate tubewell installation or the purchase of tubewell water.

[20] Several references as summarized by Dalrymple, *op.cit.,* p. 31.

[21] *Ibid.,* pp. 65, 71, 75, 78, 95; *CIMMYT Annual Report, 1972*, p. 46 (ref. to India).

[22] Letter from Don Winkelmann, CIMMYT economist (citing estimate by R. Glenn Anderson of CIMMYT), February 4, 1974; letter from Anderson, February 4, 1974.

[23] See, for example: Malcolm J. Purvis, "The New Varieties Under Dryland Conditions; Mexican Wheats in Tunisia," *American Journal of Agricultural Economics*, February 1973,

the HYV's are often superior to local varieties. Consequently, increased attention is being given to developing increased drought-resistant wheat varieties.[24]

Rice. At present the high-yielding rice varieties are largely grown in irrigated areas. About 20 percent of the rice land in South and Southeast Asia falls into the irrigated category. Another 50 percent is rainfed lowland, 20 percent is rainfed upland, and 10 percent is deep water.[25] HYV's can be raised in the rainfed lowland areas, but the rainfall uncertainty means that yields may be only slightly higher. Knowledge of the performance of high-yielding varieties under upland conditions is limited. Obviously the usual semi-dwarf and dwarf varieties do not do well under deep water conditions.[26]

The present HYV's vary in their tolerance to surplus or deficit water. Philippine farmers, for example, discovered that one variety (IR-5) was able to recover from early drought, and the variety was spreading rapidly in that country's rainfed areas until it was struck down by virus in 1971. Thai farmers found that the first high-yielding Thai varieties (RD1 and RD3) were too short to be planted in the wet season in areas subject to flooding. The most recent Thai release (RD5) is 50 percent taller than the earlier releases, and should be acceptable over a much wider area.

Research workers at IRRI and elsewhere are attempting to develop varieties which will better withstand the drought conditions associated with upland and rainfed lowland rice production,[27] or the deep water and poor drainage conditions in the low-lying areas of major river deltas.[28]

MAJOR RICE GROUPS[29]

There are two major groups of rice varieties: indica and japonica. They have quite different characteristics.[30]

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pp. 54-57; R. I. Rochin, "A Micro-Economic Analysis of Smallholder Response to High-Yielding Varieties of Wheat in West Pakistan," Michigan State University, Dept. of Agricultural Economics, Ph.D. dissertation, 1971.

[24] One approach being used at CIMMYT is to cross spring wheat with winter wheat, which has greater drought tolerance.

[25] Randolph Barker and Mahar Mangahas, "Environmental and Other Factors Influencing the Performance of New High-Yielding Varieties of Wheat and Rice in Asia," Proceedings of the *Fourteenth International Conference of Agricultural Economists*, 1971, p. 399.

[26] For a more detailed discussion of these matters, see Randolph Barker, "The Evolutionary Nature of the New Rice Technology," *Food Research Institute Studies*, Vol. X, No. 2, 1971, pp. 119, 121.

[27] For details, see *The IRRI Annual Report for 1973*, in process.

[28] For details, see B. R. Jackson, *et al.*, "Breeding Rice for Deep-Water Areas," *Rice Breeding*, 1972, IRRI, pp. 517-518.

[29] Dr. T. T. Chang of IRRI was of great help in the preparation of this section.

[30] See Takane Matsuo, *Rice and Rice Cultivation in Japan*, Institute of Asian Economic Affairs, Tokyo, 1961, pp. 9-25.

Indica is the major group grown throughout South and Southeast Asia and in most areas of the People's Republic of China. The majority of indica varieties raised in the monsoon tropics have evolved from combined natural and human selection processes. They are well adapted to conditions of low soil fertility, uncertain weather, and poor water control. Most indicas have resistance to endemic diseases and insects and compete well with weeds. They also have the dry cooking characteristics preferred by consumers in tropical and sub-tropical areas. But the features that enable the tropical types of indicas to survive—tall and high tillering plants, late maturity, long drooping leaves, etc.—also provide the basis for their weakness under modern agricultural practices. Improved fertilization, for instance, will lead mainly to vegetative growth and lodging rather than significantly increased yield.

Japonica varieties are widely distributed in different areas of the temperate zone. The varieties evolved more recently than the indicas and are the result of an intensive human selection process. In comparison with the indicas, they have darker and more upright leaves, a shorter and stiffer stalk, earlier maturity, and more thrifty vegetative growth. Japonicas respond well to improved cultural practices—especially fertilizer—and are more resistant to lodging. As a result, yields are considerably higher than for the indicas. Japonicas are not, however, well adapted for the traditional cultural practices in tropical Asia; among other things, (1) the varieties require precise water, weed, and insect control; (2) most are susceptible to the virus diseases of the tropics; (3) some react to the high temperature during early growth stage by flowering too early; (4) they lack the grain dormancy needed in the monsoon season; and (5) the grains have a sticky cooking quality not desired by consumers.

Breeding efforts, to be outlined in the next chapter, have centered about improving each of these types as well as to develop japonica and indica crosses.

II ORIGIN AND DEVELOPMENT

The origin and development of the varieties reported in this bulletin are considerably more involved than their classification as semi-dwarf Mexican wheats and IRRI rice varieties might suggest.[1]

HIGH-YIELDING WHEAT

The wheat varieties discussed here are descendents of Japanese, American, and Italian varieties and breeding efforts.

JAPANESE-AMERICAN ROOTS

Japan has had a long history in the development of dwarf wheat. In 1873, Horace Capron, former U.S. Commissioner of Agriculture who headed an agricultural advisory group to Japan, wrote that "the Japanese farmers have brought the art of dwarfing to perfection." He noted that "the wheat stalk seldom grows higher than 2 feet, and often not more than 20 inches." The head was short but heavy. The Japanese claimed that the straw had been so shortened "that no matter how much manure is used it will not grow longer, but rather the length of the wheat-head is increased." Capron noted that "on the richest soils and with the heaviest yields, the wheat stalks never fall down and lodge."[2]

The Japanese crossed one such variety, Daruma, with a strain of the American soft red winter variety, Fultz, in 1917, producing a strain known as

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[1] The reader desiring more technical detail than is provided in this chapter may wish to consult D. S. Athwal, "Semidwarf Rice and Wheat and Global Food Needs," *The Quarterly Review of Biology*, March 1971, pp. 1-34.

[2] Horace Capron, "Agriculture in Japan," *Report of the Commissioner of Agriculture for the Year 1873*, Washington, 1874, p. 369. Japanese wheats were also described in: the *Catalogue Methodiques et Synonymique des Froments*, L. de Vilmorin, Paris, 1889, 1895; and in "Ble Precoce du Japon," *Les Meilleurs Bles: Description et Culture des Principles Varietes de Froments*, H. Vilmorin-Andrieux & Co., Paris, undated (cited in a letter from A. Brandolini, Plant Production and Protection Division, FAO, Rome, March 8, 1974).

Fultz-Daruma. This strain was, in turn, crossed with the American hard red winter variety Turkey Red in 1924 and led to a number of different types. One of these was later known as Norin 10; it was registered and released to Japanese farmers in 1935.[3] The Japanese varieties, in turn, were used in breeding programs, first in Italy and then in the United States and Mexico.

ITALIAN VARIETIES[4]

In 1911, seed from some of the short-straw, early maturing Japanese wheat varieties was acquired by Dr. Ingegnoli, an Italian flower seed producer, during a trip to Japan. He, in turn, provided the wheat seed to Nazareno Strampelli at the Royal Wheat Growing Experimental Station at Rieti. Strampelli started using the Japanese varieties in his breeding programs in 1912.[5]

Strampelli was interested in developing wheat plants which would be both early ripening and resistant to lodging. Early ripening was desired to increase resistance to blast or "stretta" (wilting under hot wind stress) and rusts, and to facilitate cropping. Resistance to lodging, obtained through shorter and thicker stems, was desired so fertilizer applications could be increased. These goals (aside from resistance to "stretta") were very similar to those of later breeding programs and seem to have been largely accomplished.[6]

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[3] L. P. Reitz and S. C. Salmon, "Origin, History, and the Use of Norin 10 Wheat," *Crop Science*, November-December 1969 (Vol. 8, No. 6), pp. 686-689. It is not known exactly how Fultz and Turkey Red got to Japan, but Fultz arrived before 1892. Fultz was first selected in Pennsylvania in 1862 and could have been introduced by the Capron Mission during the early 1870's. Turkey Red, better known as Turkey, was introduced in Kansas in 1874 by a group of Russian Mennonites; it later became the leading U.S. variety. For details on Fultz and Turkey, see: J. A. Clark *et al., Classification of American Wheat Varieties*, U.S. Department of Agriculture, Bulletin No. 1074, November 1922, pp. 83-85, 144-147; and K. S. Quisenberry and L. P. Reitz, "Turkey Wheat: The Cornerstone of an Empire," *Agricultural History,* January 1974, pp. 98-114.

[4] This section developed out of brief mention of the Italian wheats in Reitz and Salmon, *op. cit.,* p. 688. Valuable assistance was provided by Dr. Reitz as well as by: A. Brandolini, *op cit.*; and Alessandro Bozzini, Director, Laboratorio per le Applicazioni in Agricultura, Centro di Studi Nucleari della Casaccia, Rome.

[5] Letters from Bozzini, *op cit.,* December 5, 1973, February 5, 1974. In 1922, Strampelli moved to "The National Institute of Genetics as Related to the Cultivation of Cereals" in Rome. Biographical material on Strampelli is provided in *Nazareno Strampelli*, Societa Ploesana Produttori Sementi, Ramo Editoriale Degli Agricoltori, Rome, 1966, 44 pp.

[6] Nazareno Strampelli, *Early Ripening Wheats and the Advance of Italian Wheat Production*, Tipografia Failli, Rome, 1933, pp. 5-7.

Of the several Japanese varieties used by Strampelli, Akagomughi appeared to be the most important. In 1913 it was crossed with Wilhelmina Tarwe X Rieti (a cross involving Dutch and Italian varieties originally made in 1906), producing two lines: (1) *m. 67* and (2) *21 ar.* The former produced Villa Glori (1918) among other well known varieties. The latter produced, among others, Ardito (1916) and Mentana (1918).[7]

Ardito was the first variety to attain wide use. It had short straw (70-80 cm.) and early-maturing characteristics. By 1926, it accounted for nearly all of the 500,000 hectares (1,240,000 acres) planted to early maturing varieties in Italy.[8] Ardito was also grown in other areas of the world and became one of the progenitors of improved Argentine varieties and of the Russian winter variety Bezostaya.[9]

Mentana was the second major variety. It differed from Ardito in that it had earlier maturity and a longer stem (90-100 cm.). Mentana attained international popularity due to its resistance to yellow rusts. Its genetic traits were bred into Frontana (Brazil) and Kentana (Mexico).[10] Mentana was also one of three varieties which played a key role in the Mexican wheat breeding program in the 1940's.[11]

As a result of a wheat campaign in Italy, an estimated 1,261,000 hectares (3,116,000 acres) of early wheats were grown by 1932. This represented 25.4 percent of the total wheat area. The early wheats, mainly Mentana and Villa Glori, were particularly concentrated in the northern provinces.[12]

The typical varieties raised during the 1930's (such as Mentana) were taller than those used in the 1920's (such as Ardito). Subsequent breeding efforts placed increased emphasis on breeding a shorter stem, and the height of most varieties ranges from 65 to 85 cm.[13] Some varieties have a stalk length of less than 40 cm.[14]

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[7] *Origini, Sviluppi, Lavori e Risultati,* Istituto Nazionale di Genetica per la Cerealicoltura in Roma, Rome, 1932, pp. 91, 92, 99-101, appendix. (Actual release dates for farm use were 4 or 5 years later than noted here.)

[8] Strampelli, *op. cit.,* p. 11, maps and tables.

[9] Letters from: R. Glenn Anderson, International Maize and Wheat Improvement Center, October 19, 1973; Brandolini, *op. cit.,* March 8, 1974; Nicolae Saulescu and J. Vallega, in *Nazareno Strampelli, op. cit.,* pp. 30, 43. (The full pedigree of Bezostaya 1 is provided in *Cereal Improvement and Production*, Information Bulletin, Near East Project, FAO, 1971, No. 2-3.)

[10] Bozzini, *op. cit.,* Brandolini, *op. cit.*

[11] Norman E. Borlaug, "Wheat Breeding and Its Impact on World Food Supply," *Proceedings of the Third International Wheat Genetics Symposium*, Canberra, 1968, p. 5. The other two varieties were Florence Aurore (Marroqui)—see fn. 16—and Gabo.

[12] Strampelli, *op. cit.*

[13] Bozzini, *op. cit.*

[14] Mairo Bonvicini, "Indirizzi della Genetica Agraria per la Resistenza All'allettamento in Triticum Vulgare," *Caryologia* (Suppl. Atti del IX Congresso Internazional di Genetica), 1954, pp. 738-743.

Italian varieties are now being grown in several less developed countries in the Mediterranean region, in particular Morocco, Algeria, and Turkey. One of the well-known varieties is Strampelli; while it is susceptible to stem rust, it has good resistance to septoria.[15] Italian and Japanese varieties were used in early breeding work in Tunisia.[16] Italian varieties are also widely used in Southeastern Europe.[17]

While the Italian varieties are generally early maturing and have relatively short straw, their stalk differs from the Mexican wheats. In some varieties, it is stiff and brittle with a completely upright head, in contrast to the more flexible Mexican-type straw.[18]

Italian varieties are currently being used in a number of nations, and appear to have played an important role in the development of other varieties, including some of the early Mexican varieties.

MEXICAN VARIETIES

In 1946, Dr. S. C. Salmon, a U.S. Department of Agriculture scientist acting as agricultural advisor to the occupation army in Japan, noticed Norin 10 growing at the Moricka Branch Research Station in northern Honshu. The stems were short, about 60 cm, but produced many full-sized heads. Dr. Salmon brought 16 varieties of this plant type to the United States. They were grown in a detention nursery for a year and then made available to breeders in seven locations.

Although Norin 10 was not satisfactory for direct use in the United States, it was useful for breeding. Dr. Orville A. Vogel, a U.S. Department of Agriculture scientist stationed at Washington State University, was the first to recognize its worth and to use it in a breeding program in 1949. Crossing Norin 10 with U.S. varieties involved some problems, but a number of semi-dwarf lines were eventually developed.[19]

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[15] Anderson, *op. cit.*; letter from Willis McCuistion, Project Cereales–CIMMYT, Algiers, Algeria, December 11, 1973.

[16] F. Boeuf, "Le Ble en Tunisie," *Annales du Service Botanique et Agronomique,* Tunis, Tome VIII, 1932, pp. 96-110. In addition, several hybrids obtained from Emile Schribaux of Versailles early in the century reportedly had stiff stems and were early ripening. The most important was Florence x Aurore; it was received in 1922, released for general cultivation in 1930/31, and is still widely grown. It is quite similar to the Mexican varieties; in fact, Florence-Aurore, known as Marroqui, was used in the Mexican breeding work (see fn. 11). (*Ibid.,* pp. 60, 61; letter from George Varughese, CIMMYT, c/o Ford Foundation, Tunis, February 8, 1974.)

[17] Letter from Bill C. Wright, Wheat Research and Training Center, Ankara, November 8, 1973. Wright specifically mentions Albania, Bulgaria, Hungary, and Yugoslavia. Also see Saulescu, *op. cit.*

[18] Anderson, *op. cit.*

[19] Reitz and Salmon, *op.cit.,* pp. 686-687; L. P. Reitz, "Short Wheats Stand Tall," *1968 Yearbook of Agriculture*, U.S. Department of Agriculture, pp. 236-237; L. P. Reitz, "New Wheats and Social Progress," *Science*, September 4, 1970, pp. 952-955.

In the interim, word about the short-strawed germ plasm had reached Dr. Norman Borlaug in Mexico.[20] His breeding efforts had run into a yield plateau because of lodging under high levels of nitrogen fertilization. In his words:

> We had recognized the barriers on yield imposed by lodging as early as 1948, but we had been frustrated in our search for a useable form of dwarfness to overcome this problem until the discovery of the so-called Norin dwarfs. In 1953 we received a few seeds of several F_2 selections from the cross Norin 10 X Brevor from Dr. Orville Vogel. Our first attempts to incorporate the Norin 10 X Brevor dwarfness into Mexican wheats in 1954 were unsuccessful . . . A second attempt in 1955 was successful, and immediately it became evident that a new type of wheat was forthcoming with higher yield potential.[21]

The introduction of the Norin 10 genes led to the development of a number of Mexican dwarf and semi-dwarf bread wheat varieties: Pitic 62, Penjamo 62, Sonora 63, Sonora 64, Mayo 64, Lerma Rojo 64, Inia 66, Tobari 66, Ciano 67, Norteno 67, and Siete Cerros. In addition, a semi-dwarf durum, Oviachic 65, was developed. (The number in each after the varietal name indicates the approximate year of introduction; Pitic 62 and Penjamo 62, for example, were first released to farmers in 1963.[22]) The genetic origins of these early hybrid varieties are depicted in Figure 1.[23]

No attempt will be made to trace all the important varieties developed at CIMMYT or from CIMMYT stock; there are simply too many, and details are readily available from CIMMYT annual reports and other CIMMYT publications.[24] Besides, CIMMYT does not view the development of finished

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[20] The Rockefeller grain program in Mexico began in 1943. It was conducted in cooperation with the Office of Special Studies of the Ministry of Agriculture. In 1959, Borlaug became director of Rockefeller's International Wheat Improvement Project. The wheat program was merged with a comparable corn program in October 1963 to form the International Center for Corn and Wheat Improvement. Work sponsored by the Mexican Government was shifted from the Office of Special Studies to the National Institute of Agricultural Research in January 1961. (Stakman, *et al., op. cit.*, pp. 5, 12, 273.)

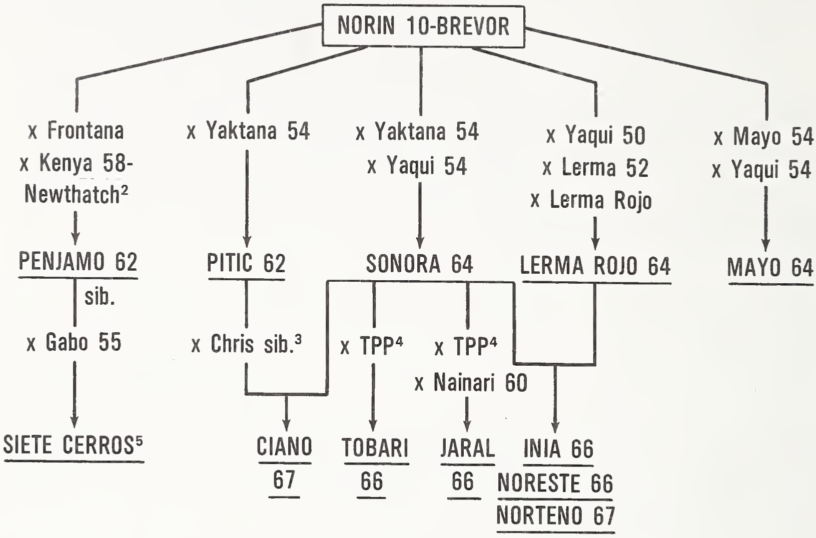
[21] Borlaug, *op. cit.*, p. 6. Although the Italian variety Mentana was, as noted in the previous section, used in early breeding efforts, it had a relatively long stem and was not in the semi-dwarf category; it did, however, introduce daylength insensitivity. For further discussion of the use of Mentana, see fn. 23 below and and Stakman, *et al., op. cit.*, pp. 84-88 (curiously, this book says very little about the Norin 10 types).

[22] Borlaug, *op. cit.*, pp. 6-7. Pitic was the first semi-dwarf variety to be released.

[23] Mentana was one of the parents or grandparents of several of the varieties crossed with Norin 10-Brevor: Frontana (from Brazil), Lerma 52, Lerma Rojo[2], and Yaktana 54. It was also a parent of: Gabo 60; Kentana 48, 51, 52; Lerma 50, 51; and Nainari 60. Florence Aurore, under the name Marroqui, was one of the parents of Yaqui 50, as well as of Mayo 48 and Yaqui 48. (Letter from R. G. Anderson, CIMMYT, February 25, 1974; Brandolini, *op. cit.*; Stakman, *et al., op. cit.*, p. 86, "Nombre, Genealogia y Abreviaturas de Trigos Mexicanos," Ministry of Agriculture and CIMMYT, September 1967, 4 pp.)

[24] For genetic detail, for example, see *Results of the Fifth International Spring Wheat Yield Nursery, 1968-1969*, CIMMYT, Research Bulletin No. 19, March 1971, pp. 4-8.

Figure 1. GENETIC INTERRELATIONSHIPS OF EARLY SEMI-DWARF CIMMYT WHEATS[1]



[1] The presentation of some of the more complex crosses is simplified for graphic purposes. For example, the percentage of Lerma Rojo 64 would be more precisely written as: [(Yaqui 50 X Norin 10-Brevor) Lerma 52] Lerma Rojo^2.

[2] Frontana X Kenya 58-Newthatch was bred in Minnesota.

[3] From Minnesota.

[4] Tezanos Pintos Precoz; from Argentina.

[5] Reselection known as Mexipak 65 in Pakistan and as Kalyan 227, S-227, and V-17 in India. Red "sister" known as Super X in Mexico, Indus 66 in Pakistan, and PV-18 and V-18 in India.

Sources: *CIMMYT Annual Report, 1972,* p. 15; *Results of the Fifth International Spring Wheat Yield Nursery, 1968-1969,* CIMMYT, Research Bulletin No. 19, March 1971, pp. 6-7; "Nombre, Genealogia y Abreviaturas de Trigos Mexicanos," Ministry of Agriculture and CIMMYT, September 1967, 4 pp.; letter from R. G. Anderson, CIMMYT, February 25, 1974.

varieties as its main purpose; rather, it provides improved lines to national programs which, in turn, tailor them to local conditions. In some cases it also provides staff members to collaborate and help improve the national breeding efforts.[25]

India, however, provides an interesting example of the varietal changes that have taken place. In 1963, Dr. Borlaug sent 100 kg (220 lbs) of several Mexican

[25] *CIMMYT Annual Report, 1970-71,* pp. 13, 14.

varieties to India; included were Mayo 64, Sonora 63, Sonora 64, Lerma Rojo 64, and line 8156. In the summers of 1965 and 1966, large quantities of Sonora 64 and Lerma Rojo seed—both with a red grain—were imported from Mexico and widely planted. Meanwhile, breeding work continued in India using line 8156; in 1967, three amber grained strains were released: Kalyan Sona, Sonalika, and Chotti Lerma (S. 331). Also, amber strains of Sonora 64 and Lerma Rojo 64 were developed; they are known respectively as Sharbati Sonora and Safed Lerma.[26] By November 1969, the Indian Planning Commission was able to report that "the pure Mexican varieties introduced earlier had been practically replaced."[27] And a subsequent CIMMYT report stated that India was entering the third and fourth cycle of dwarf wheat development. The third cycle represents Indian varieties such as Lal Bahadur, U.P. 301, and Kiran which were developed from introduced materials and subsequently selected entirely under Indian conditions. The fourth cycle represents varieties that are being developed from crosses made in India, most frequently involving Indian and CIMMYT-Mexican parents.[28]

HIGH-YIELDING RICE[29]

The origins of the high-yielding varieties have their roots deep in history and represent a melange of many different efforts and programs.

CHINESE ANTECEDENTS

The People's Republic of China has perhaps the most extended history of rice improvement.[30] As with other countries, much of this was simply farmer selection of improved varieties for local use.

The most significant recorded early step took place around 1000 A.D. when a new rice, Champa, was introduced into Fukien from Indochina. After 1012, it was introduced into the lower Yangtze and lower Huai areas. Champa had several outstanding features; it was relatively early ripening (100 days after

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[26] Developed from information provided in: Carroll P. Streeter, *A Partnership to Improve Food Production in India*, The Rockefeller Foundation (undated; 1969 or 1970), pp. 12-17; letter from James H. Boulware, Agricultural Attache, American Embassy, New Delhi, June 12, 1970.

[27] *Evaluation Study of High Yielding Varieties Programme, Report for the Rabi 1968-69—Wheat, Paddy and Jowar,* Government of India, Planning Commission, Program Evaluation Organization, p. ii. Kalyan Sona accounted for about one-fourth of the production (p. 49).

[28] *CIMMYT, 1969-70 Report,* pp. 85-96.

[29] Dr. T. T. Chang of the International Rice Research Institute was of great help in the preparation of this section.

[30] See: Dwight H. Perkins, "Improved Seed," *Agricultural Development in China, 1368-1968*, Aldine, Chicago, 1969, pp. 38-41; Leslie T. C. Kuo, "Seed Selection," *The Technical Transformation of Agriculture in Communist China*, Praeger, 1972, ch. 9, pp. 143-160.

transplanting) and drought resistant. Although indigenous early-ripening rices had been in use previously, their adoption was very limited.

Following the introduction of Champa, however, the use of early-ripening rice expanded, especially in southeast China. Other shorter season varieties were developed in the 11th and 12th centuries. By the early 1830's the area under early maturing varieties reportedly exceeded that under traditional types. While most were probably used for early season planting, thereby allowing double cropping, some were used to plant after severe droughts or floods.[31]

The major types of rice grown in China are indica and japonica (defined in Chapter I). Indicas have traditionally been raised in Southern China and japonicas have been grown in more northerly locations.[32] Attempts have been made, both in China (see Appendix A) and in other countries, to improve both types of rice for use in the tropics and other regions.

JAPONICA VARIETIES

Research on this group was initiated in Japan nearly 70 years ago. Successes were obtained in breeding more nitrogen-responsive and disease-resistant types.[33] A breeding program to develop daylength- and temperature-insensitive types was initiated in Taiwan in the early 1920's and resulted in the "ponlai" varieties (such as Taichung 65).[34] They made double cropping of rice possible, using a single variety for both crops.[35] Between 1925 and 1940, 50 percent of the rice land in Taiwan was shifted to the ponlai varieties.[36] Subsequent research verified their high-yielding ability over a wide area in tropical Asia and Africa.[37] But the ponlais did not gain wide commercial acceptance because of disease problems and undesirable grain features.

JAPONICA X INDICA CROSSES

The FAO-India program noted earlier (Ch. I, fn. 9) was an attempt to cross japonica and indica varieties. Results were generally not satisfactory because

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[31] Ping-ti Ho, "Early Ripening Rice in Chinese History," *The Economic History Review*, December 1956, pp. 200-216. The origins of rice in China are discussed by Ho in "The Loess and the Origin of Chinese Agriculture," *American Historical Review*, October 1969, pp. 19-26.

[32] T. H. Shen, *Agricultural Resources of China*, Cornell University Press, 1951, p. 197.

[33] Matsuo, *op. cit.* (Ch. I fn. 30), pp. 20-27, 91-93.

[34] Several of the ponlai varieties included an indica in their parentage. Details on the development of ponlai varieties are provided in E. Iso, *Rice and Crops in Its Rotation in Subtropical Zones*, Japan FAO Association, Tokyo, 1954, pp. 106-137.

[35] C. H. Huang, W. L. Chang, and T. T. Chang, "Ponlai Varieties and Taichung Native 1," paper represented at the Symposium on Rice Breeding, IRRI, September 1971, 30 pp.

[36] S. C. Hsieh and V. W. Ruttan, " . . . Factors in the Growth of Rice Production . . .," *Food Research Institute Studies*, 1967 (No. 3), p. 331.

[37] T. T. Chang, "The Genetic Basis of Wide Adaptability and Yielding Ability of Rice Varieties in the Tropics," *International Rice Commission Newsletter*, December 1967, pp. 4-15.

nearly all of the japonica parents were from Japan and were poorly adapted to a tropical climate. But one hybrid, ADT-27, did show a substantial improvement over local varieties and subsequently was widely planted in the Tanjore District. This breeding program also produced a few other varieties. One, Mahsuri, (Taichung 65 X Mayang Ebos 80), was further developed in Malaysia with Japanese assistance and is now extensively planted.[38] Recently, a cooperative project between Korean scientists and the International Rice Research Institute has led to the introduction of Tongil, a cross between IR-8 and (Yukara X TN-1).[39]

INDICA VARIETIES

Attempts to improve indica varieties in the 1940's and 1950's were moderately successful. Results of this work include H-4 and H-5 in Ceylon and Peta, Sigadis, Bengawan, and Remadja in Indonesia.

Taichung Native 1 (TN-1) was developed in Taiwan after World War II by crossing Dee-geo-woo-gen, a short variety thought to have come from Fukien Province in southern China several hundred years before,[40] with Tsai-Yuan-Chung, a tall drought-resistant local variety. It was the first indica to respond to fertilization as well or better than the ponlais.[41] TN-1 had its major impact on rice production in India. Jaya and Padma, relatively new Indian varieties, represent a cross of TN-1 and T 141, a tall Indian variety from Orissa.[42] More recent releases in India are Hamsa, Krishma, Cauvery, Bala, Ratna, Vijaya, CO-34, Jamuna, Sabarmati, Pankaj, and Jagannath.[43] In Thailand, a 1964 cross of TN-1 with a local variety (Gam Pai 15/2) produced RD2, a glutinous variety grown in the Northeast.[44] These and other TN-1 crosses are listed in Table 1.

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[38] Malinja, another variety developed in the same program and planted in Malaysia, represents a cross between two indicas, Siam 29 and Pebifun. Pebifun originally came from Taiwan where it was once a leading variety. (Letter from Chang, October 27, 1970.)

[39] "IR667-98, A Cool Climate Semidwarf," *The IRRI Reporter*, No. 1, pp. 1-2.

[40] Noted in T. S. Miu (ed.), *A Photographic Monograph of Rice Varieties of Taiwan*, Taiwan Agricultural Research Institute, Special Publication No. 2, December 30, 1959, p. 67.

[41] See T. T. Chang, *Recent Advances in Rice Breeding in Taiwan*, Joint Commission on Rural Reconstruction, Plant Industry Series 22, 1961, pp. 33-58.

[42] S. V. S. Shastry, "New High-Yielding Varieties of Rice: Jaya and Padma," *Indian Farming*, February 1969, pp. 5-13; Streeter, *op. cit.*, pp. 26, 28.

[43] *Morphological and Physiological Characteristics of Some High-Yielding Rice Varieties*, IADP Technical Bulletin 9, 1970, 41 pp. (Eluru, India); letter from Chang, September 24, 1971. Pankaj and Jagannath are similar in height to IR-5.

[44] For details on the Thai breeding program, see: Delane Welsch and Sopin Tongpan, "Background to the Introduction of High-Yielding Varieties of Rice in Thailand," University of Minnesota, Department of Agricultural and Applied Economics, Staff Paper 72-6, February 1972, pp. 21-25; and the articles on dwarf varieties by B. R. Jackson, *et al.*, and A. C. Yantasast, *et al.*, in the *Thai Journal of Agricultural Science*: 1969, pp. 83-92; 1970, pp. 119-133.

Table 1—HYV varieties named from IRRI lines or developed in national programs[1]

Cross	Country	Variety
TN-1 Parentage		
TN-1 X T 141	India	Jaya, Padma
TN-1 X Peta/3	Ivory Coast	CS-1
	Sri Lanka	IR-262
	Fiji	Ajral
TN-1 X Nahng Mon S-4	Ivory Coast	CS-2
	Mexico	Sinaloa A68
TN-1 X Gam Pai 15/2	Ivory Coast	CS-3
	Thailand	RD-2
(TN-1 X Peta/2) X Leb Mue Nahng	Peru	Huallaga
(TN-1 X Peta/3) X TKM-6	Bangladesh	Chandina and Irrisail
(sister selection of IR-20)	Sri Lanka	IR-532
TN-1 X Peta/4	Nepal	Parwanipur I
(TN-1 X Peta/4) X BG79	Guyana	S
(TN-1 X Sigadis/2) X IR24	South Vietnam	TN73-1
IR-8 Parentage		
(IR-8 X Tadukan)	El Salvador	Nilo 11
(sister selection of IR-22)[2]	India	Palman 579
IR-8 X IR-12-178	Colombia	CICA 4[3]
	Dominican Rep.	Advance 72[3]
	Ecuador	INIAP 6[3]
	Peru	Chancay and Naylamp
IR-8 X BG 79	Guyana	R
IR-8 X (Yukara X TN-1)[4]	Korea	Tongil
IR-8 X [(CP230 X SLO-17) Sigadis] (sister line of IR-24)	Taiwan	Chianung-sen 8
IR-8 X Muey Nahng 62M	Malaysia	Masria
IR-8 X Leuang Tawng	Thailand	RD1, RD3
(IR-8 X Tadukan) X (TKM-6/2 X TN-1)	South Vietnam	TN73-2
IR-5 Parentage		
IR-5 X Syntha	Indonesia	Pelita I/1 and Pelita I/2
Other Parentages		
Peta X Tangkai Rotan (sister selection of IR-5)	Malaysia	Bahagia
	India	Pankha
Siam 29 X Dee-geo-woo-gen	Pakistan	Meheran 69
Sigadis X (CP231 X SLO-17)/2	Bangladesh	Mala

[1] IRRI line numbers have not been listed in order to simplify the presentation.

[2] IR-22 itself is known as INIAP 2 in Ecuador and Navolato A-71 in Mexico.

[3] CICA 4 was developed cooperatively by the Centro Internacional de Agricultura Tropical (CIAT) and the Instituto Colombiano Agropecuario (ICA) and was released in

early 1971. (Details are provided in the CIAT annual reports for 1971 and 1972 and in *Noti-Ciat*, May-June, 1971.) It is known as CICA 4 in most Latin American countries but has been given different names in the Dominican Republic and Ecuador.

[4] An indica-japonica cross.

Principal Sources: *IRRI Annual Report for 1971*, p. 181; *IRRI Annual Report for 1972*, pp. 155-157; *The IRRI Reporter*, 2/72; *CIAT Annual Report, 1971* (p. 46). p. 128; *IRRI Annual Report for 1973* (in process).

Breeding work in the Philippines was carried out both by the national government and the International Rice Research Institute (IRRI). National programs produced BPI-76 and C4-63 (Peta X BPI-76), both now widely planted. The IRRI program began in the early 1960's and through 1973 produced six varieties of international importance, plus a number of lines which have been named by other agencies (Table 1).

IR-8, the first of the IRRI semi-dwarf varieties, was obtained by crossing Peta with Dee-geo-woo-gen. The initial cross was made in 1962 and the variety was released in November 1966.[45]

IR-5 was developed concurrently from a cross between Peta and Tangkai Rotan, a Malaysian variety (hence, IR-5 does not have the same Chinese semi-dwarf gene as IR-8, but is of moderately short height). It was announced in December 1967.[46]

IR-20 and IR-22. IR-20 was selected from a cross between IR-262-24-3 (a descendent of a cross between Peta and TN-1) and TKM-6, an Indian variety. IR-22 was selected from a cross between IR-8 and Tadukan, a Philippine variety. Both IR-20 and IR-22 were named in December 1969.[47] Both represented a considerable improvement in grain quality over IR-8 and IR-5.

IR-24 was developed from a cross of IR-8 and [(CP230 X SLO-17) X Sigadis] and named in May 1971. It has slender grains similar to those of IR-22, but the cooked rice is soft and moist.[48]

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[45] For details, see Robert F. Chandler, "Dwarf Rice—A Giant in Tropical Asia," *1968 Yearbook of Agriculture*, pp. 252-255; Streeter, *op. cit.*, pp. 26-29. IR-8 was subsequently renamed Rizal 1 and Magsaysay in the Philippines.

[46] Further information is provided in "IR-5—A New High-Yielding IRRI Variety," *IRRI Reporter*, January 1968, 4 pp.

[47] The additional information is found in "IR-20 and IR-22, New Rice Varieties," *The IRRI Reporter*, January 1970, 4 pp.

[48] Further details are presented in: "IR-24—A Low Amylose Variety," *The IRRI Reporter*, No. 2, 1971, pp. 1-2; and the *IRRI Annual Report for 1971*, p. 182.

IR-26 was developed from a cross between IR-24 and TKM-6 (the Indian variety used in breeding IR-20) and was released in November 1973. It is resistant or moderately resistant to most major rice insects and diseases in tropical Asia. The eating quality is slightly better than IR-20.[49]

The interrelationships between the above varieties are depicted in Figure 2. Note that Peta was included in the ancestry of all the IRRI varieties.[50] In some cases these varieties have been reissued under other names in other countries; they will be noted in the footnotes to the country tables in Chapter IV. In other cases they have been crossed with other varieties to produce new IRRI lines; these in turn have been given various names in other countries (Table 1).

The trend in development of varieties is toward improved eating quality and resistance to various pests. IR-8 is being gradually, and in some cases entirely, replaced in many areas by the newer varieties. A detailed comparison of the major characteristics and resistance ratings of the six IRRI varieties is provided in Tables 2 and 3.[51]

Clearly, a wide range of characteristics and crosses have now been developed from a few original varieties. More are currently under development and will appear in the future.

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The specific wheat and rice varieties which have been outlined in this chapter will reappear in the footnotes of many of the country tables in the next two chapters. It was not possible to obtain a complete varietal breakdown for each country, but such information is included where reported.

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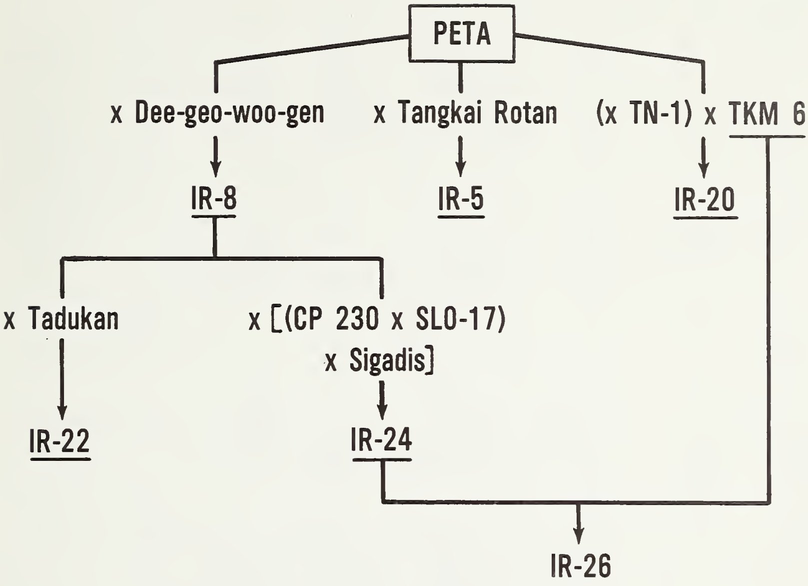
[49] Further details are provided in "IR-26 is Resistant to Brown Planthoppers," *The IRRI Reporter*, No. 4, 1973, pp. 1-2.

[50] Peta came from a cross of Tjina × Latisail. Tjina is synonymous with China; Latisail came from Bangladesh. Other varieties produced from the same cross by Indonesian-Dutch breeders in 1940-41 included Mas, Intan, and Bengawan (Z. Harahap, *et al.*, "Breeding Rice Varieties for Indonesia," *Rice Breeding,* IRRI, 1972, p. 142).

[51] Also see "IR-8 and Beyond," *The IRRI Reporter*, No. 2, 1972, pp. 1-2.

Figure 2. GENEALOGY OF THE IRRI RICE VARIETIES[1]



[1] The genealogy of some varieties has been simplified slightly for graphic purposes. IR-20, for instance, originated from a cross between Peta and IR-262-24-3, a descendent of a cross between Peta and TN-1.

Table 2—Major characteristics of IRRI varieties

Character	IR-8	IR-5	IR-20	IR-22	IR-24	IR-26
Growth duration						
Dry season (Dec. seeding)	125 days	135 days	120 days	115 days	120 days	125 days
Wet season (June seeding)	130 days	145 days	135 days	130 days	120 days	125 days
Sensitive to photoperiod	no	weakly	weakly	weakly	no	no
Grain						
Length	medium	medium	medium	long	long	medium
Width	bold	bold	slender	slender	slender	slender
Appearance	some white belly	some white belly	translucent	translucent	translucent	translucent
Head rice recovery	low	moderate	high	high	high	high
Amylose content	high	high	mod. high	high	low	high
Gel consistency	high	low	medium	high	low	medium-low
Gelatinization temperature	low	intermediate	intermediate	low	low	low
Seed dormancy	moderate	moderate	moderate	moderate	moderate	moderate
Seedling vigor	very good	very good	very good	good	good	good
Height	90-105 cm	130-140 cm	110-115 cm	95-105 cm	100-110 cm	100-110 cm
Tillering ability	high	high	high	high	moderate	high

Source: *The IRRI Reporter*, No. 4, 1973.

Table 3—Resistance ratings of **IRRI** varieties

Problem	IR-8	IR-5	IR-20	IR-22	IR-24	IR-26
Lodging	R[1]	MR	MR	R	R	MR
Diseases						
Blast	MR	S	MR	S	S	MR
Bacterial blight	S	S	R	R	S	R
Bacterial leaf streak	S	MS	MR	MS	MR	MR
Grassy stunt	S	S	S	S	S	MR
Tungro	S	S	R	S	MR	R
Insects						
Green leafhopper	R	R	R	S	R	R
Brown planthopper	S	S	S	S	S	R
Stem borer	MS	S	MS	S	S	MR
Soil Problems						
Alkali injury	S	S	S	S	MR	MR
Salt injury	MR	MR	MR	S	MR	MR
Iron toxicity	S	S	R	MR	MR	R
Reduction products	MR	MS	MR	MR	MS	MR

[1] Key: R = Resistant
MR = Moderately resistant
MS = Moderately susceptible
S = Susceptible

Source: *The IRRI Reporter*, No. 4, 1973.

III. HIGH-YIELDING WHEAT VARIETIES

This chapter summarizes available data on the area of high-yielding varieties of wheat planted or harvested, and fragmentary information on seed imports for 14 developing nations, 11 in Asia and 3 in Africa. A separate table is provided for each of the 14 countries. The scattered data for other nations, where available, are briefly summarized in regional introductions.

The tables provide annual data on major seed imports and the HYV area planted or harvested. Further details are presented in footnotes. A reference is provided for each statistic cited. Data which are particularly tentative or which are preliminary estimates for 1973/74 are also placed in parentheses. Statistics are generally rounded to the nearest hundred; consequently, the hectare and acre figures do not convert precisely. The country tables are followed by a table summarizing available information on seed imports, through 1970, for several countries where we do not yet have statistics on area planted.

Notably lacking from the coverage is any nation in Latin America. As stated in Chapter I, Mexico and Guatemala were heavily planted to improved varieties in the 1950's (going over 90 percent in Mexico in 1957). While these varieties were replaced by the semi-dwarfs reported here, we have no annual data on their spread. CIMMYT and its predecessor organization have worked closely with many Latin American nations in wheat improvement programs, but, as yet, the more recent semi-dwarf varieties do not seem to be heavily planted in any readily identifiable form.[1]

[1] For details, see Stakman, *et al., op. cit.*, pp. 216-234, and the annual reports from CIMMYT.

ASIA

India and Pakistan account for most of the HYV wheat area in Asia. They are followed at some distance by Iraq, Turkey, and Afghanistan. The other Asian nations have rather limited areas.[2]

Data for the Near East countries are particularly difficult to obtain. This has led to some inconsistencies in classification: in Turkey, for example, improved winter wheats such as Bezostaya are excluded from the main table; in Iran, they are included simply because all of the improved wheat varieties are lumped together in the reporting.

Although the Communist nations are not included in the tabular coverage, it might be noted that the Mexican wheats are well known to the People's Republic of China. In 1973, a visiting Mexican scientist found all the Mexican dwarf wheats released since 1960 growing in Chinese research stations. In October of the same year, the Chinese Embassy in Mexico sent two staff members to CIMMYT to discuss research work and collect publications.[3] The Chinese imported 2 metric tons (M.T.) of wheat seed from Mexico in 1972 and 5,034 tons in 1973 (through September). Extensive research trials would seem to be in the offing.[4]

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[2] In addition to the countries listed, about 14,000 hectares (35,000 acres) were reportedly planted to Mexican-type varieties, principally Pitic 62, on Cyprus (letter from Abdul Hafiz, Project Manager, Regional Field Food Crops Project, Food and Agriculture Organization, Cairo, December 6, 1973).

[3] Letter from Haldor Hanson, Director, CIMMYT, January 17, 1974.

[4] Letter from Richard A. Smith, Agricultural Attache, American Embassy, Mexico City, January 18, 1974 (data from the Director General of Statistics, Secretariat of Industry and Commerce). According to subsequent information received from the Mexican national seed agency, Productora Nacional de Semillas, the total for the two years was 5,016.5 tons; the 1973 shipment included a wide selection of 1970-71 varieties. (Letter from Hanson, *op. cit.,* April 17, 1974, enclosing letter from Dr. Mario Vela Cardenas of Productora . . . , April 2, 1974.)

Table 4—Afghanistan: HYV wheat seed imports and area planted or harvested

Crop year	Seed imports	Area planted or harvested	
	Metric tons	*Hectares*	*Acres*
1965-66	50[1] (1)	—	—
1966-67	420[2] (2) (3)	1,800	4,500[4] (5)
1967-68		22,000	54,400 (6)
1968-69		122,000	301,500 (6)
1969-70		146,000	360,800 (7)
1970-71		232,000	573,200 (8)
1971-72	6,000[3] (4)	255,000	630,000 (8)
1972-73		450,000	1,112,000 (8)

[1] Lerma Rojo 64A. Imported from Mexico in 1965.

[2] Lerma Rojo 64: 250 M.T. from Mexico (ref. 2 below), and 170 M.T. from Pakistan (ref. 3 below).

[3] Mexipak from Pakistan; 2,000 M.T. certified, 4,000 M.T. uncertified. As of December 1971, the certified seed had been received and planted; the uncertified seed was received in time for spring planting (some lots, however, were reported to have low germination and to be weevily). These imports were stimulated by a prolonged drought.

[4] Of this total, nearly 2,000 acres were Lerma Rojo 64A and 1,900 Tascosa.

REFERENCES

(1) "The Green Revolution," *Participant Report*, USAID, Kabul, Summer 1969, p. 2.

(2) *Fourth Annual Wheat Seminar, August 28, 1969—September 8, 1969,* Ministry of Agriculture and Irrigation, Kabul; summary paper by Joe Motheral.

(3) *CIMMYT Report*, 1967-68, pp. 59, 72.

(4) Letters from John R. Wilson, Food and Agriculture Officer, USAID, Kabul: November 27, 1971; December 22, 1971; November 17, 1973.

(5) *Agricultural Development in Afghanistan, with Special Emphasis on Wheat*, U.S. Agricultural Review Team, July 1967, pp. 31-32.

(6) Department of State Airgram TOAID A-574 from Kabul, December 8, 1969, p. 8 (Table II).

(7) Letter from Joe R. Motheral, Food and Agriculture Officer, USAID, Kabul, September 23, 1970.

(8) Letters from Wilson, *op. cit.,* October 24, 1973, November 17, 1973.

Table 5—Bangladesh: HYV wheat seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested	
	Metric tons	*Hectares*	*Acres*
1968/69		8,400	20,800 (1)
1969/70		9,100	22,500 (1)
1970/71		13,500	33,400 (1)
1971/72		15,000	37,000 (2)
1972/73		21,450	53,000 (2)

REFERENCES

(1) Foreign Agricultural Service Report BD-3012 from Dacca, April 18, 1973 (based on statistics provided by the Bureau of Agricultural Statistics, Directorate of Agriculture).

(2) Letter from Carl O. Winberg, Agricultural Attache, American Embassy, Dacca, October 15, 1973.

Table 6—India: HYV wheat seed imports and area planted or harvested[1]

Crop year	Quantity of seed imported	Area planted or harvested	
	Metric tons	*Hectares*	*Acres*
1965/66	250[2] (1) (2)	3,000	7,400 (3)
1966/67	18,000[3] (1) (2)	540,900	1,336,600[4] (4)
1967/68		2,942,000	7,269,700[4] (4)
1968/69		4,792,700	11,842,800[4] (4)
1969/70		4,917,600	12,151,400[4] (4)
1970/71		6,480,000	16,012,000[4] (4)
1971/72		7,861,400	19,425,500[4] (4)
1972/73		10,236,800	25,295,200[4] (4)
(1973/74)		(11,496,100)	(28,406,900)[5](4)

[1] See Chapter II (wheat) for a discussion of the evolution of Mexican varieties in India.
[2] 200 M.T. of Sonora 64 and 50 M.T. of Lerma Rojo 64.
[3] Mostly Lerma Rojo 64; remainder Sonora 64.
[4] The distribution of this area by state was:

	Uttar Pradesh	*Punjab*	*Other*	*Total*
		Percent		
1966/67	67	11	22	100
1967/68	54	22	24	100
1968/69	52	21	26	100
1969/70	33	29	38	100
1970/71	30	23	47	100
1971/72	28	22	50	100
1972/73	31	17	52	100

[5] Total of state targets. The Government of India target was 25,452,000 acres. Preliminary estimates suggest that the actual area changed little from 1972/73 due to input shortages and other factors.

REFERENCES

(1) *Rice and Wheat in India.* Spring Review (AID), March 10, 1969, p. 7.

(2) *Five Years of Research on Dwarf Wheat*, Indian Agricultural Research Institute, New Delhi, 1968, Preface; Grant Cannon, "On the Eve of Abundance," *Farm Quarterly*, Fall Forecast, 1967, pp. 89-90.

(3) *1966/67 CIMMYT Report*, p. 67.

(4) Unpublished data from the Ministry of Agriculture; forwarded by Horace Davis, Agricultural Attache, American Embassy, New Delhi, October 19, 1973. Estimates for 1966/67 to 1969/70 are similar to those provided in the "Reports on Price Policy for Kharil Cereals," issued by the Agricultural Prices Commission in August 1970 (p. 27) and September 1971 (Table 4).

Table 7—Iran: HYV wheat seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested	
	Metric tons	*Hectares*	*Acres*
1968/69	1,500[1] (1)	10,000	25,000[3] (3)
1969/70	4,000[2] (2)	90,000	222,400[4] (4)
1970/71		250,000	617,750[5,6] (5)
1971/72		277,000	684,500[5,7] (5)
1972/73		298,000	736,400[5,8] (5)
(1973/74)			[9]

[1] Penjamo 62 imported from Turkey.

[2] About 2,500 M.T. of Bezostaya No. 1 from USSR and 1,500 M.T. of Mexican Inya 66 from Denmark. Of the Bezostaya seed, 500 M.T. were planted during the 1969/70 season and 2,000 M.T. during the 1970/71 season (ref. 6).

[3] Penjamo 62.

[4] Mexican type wheat.

[5] May include all improved varieties.

[6] In addition, about 27,000 acres of Bezostaya could have been planted considering the seed available (ref. 6).

[7] In 1971/72, approximately 250,000 hectares were planted under the Impact Program. About 48 percent was planted to the Mexican spring wheats (Inia 66, Tobari 66, and Penjamo 62) and 52 percent to winter wheats, including Bezostaya and two locally improved varieties (Roshan and Ommid) (ref. 7).

[8] Of a total 31,400 M.T. of wheat planted during 1972/73, about 46.7 percent was Mexican-type spring wheats, 18.8 percent Bezostaya, and 34.4 percent Iranian types such as Omid, Roshan, and Tabassi-Sholeh (ref. 8).

[9] Wheat seed available for 1973/74 included: Iria 12,180 M.T.; Bezostaya 4,883; Tabassi 1,752; and Penjamo 656 (ref. 9).

REFERENCES

(1) Foreign Agricultural Service Reports from Tehran: IR-9003, January 20, 1969; IR-9006, February 5, 1969.

(2) Foreign Agricultural Service Report IR-0018 from Tehran, October 8, 1970.

(3) Foreign Agricultural Service Telegram TOFAS 60 from Tehran, October 25, 1969.

(4) Foreign Agricultural Service Telegram TOFAS 83 from Tehran, December 17, 1970.

(5) Letters from Dr. Abdul Hafiz, Regional Consultant, Cereal Improvement and Production Project, FAO, Cairo, December 6, 1973 and January 28, 1974. (Data cited by the Minister of Agriculture at opening of a wheat seminar.)

(6) Letter from Dale K. Vining, Agricultural Attache, American Embassy, Tehran, December 29, 1973.

(7) *CIMMYT Annual Report, 1972*, pp. 52, 53.

(8) Letter from Dale K. Vining, Agricultural Attache, American Embassy, Tehran, March 4, 1974.

(9) Letter From Dale K. Vining, Agricultural Attache, American Embassy, Tehran, December 29, 1973.

Table 8—Iraq: HYV wheat seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested	
	Metric tons	*Hectares*	*Acres*
1965/66	5[1] (1)	—	—
1967/68	800[2] (2)	6,400	15,800[1] (1) (4)
1968/69		41,700	103,000[1] (1)
1969/70		195,200	482,400[1] (1)
1970/71		125,000	309,000[1] (4)
1971/72	70,000[3] (3)	950,000	2,347,500[4,5] (3)
1972/73		457,000	1,129,200[4,6] (5)

[1] Mexipak.

[2] Mexipak shipped from West Pakistan, September 1968.

[3] Mexican varieties imported in response to a drought-induced crop failure in 1970/71. According to Mexican sources, 61,000 M.T. of seed wheat were shipped to Iraq in 1971 (the business was handled by a Swiss firm and the exports are listed as going to Switzerland in the official Mexican statistics) (ref. 6). Of the 60,000-ton total, about 25,000 tons were Mexipak, 20,000 tons Inia, and 15,000 tons Jori (ref. 7). In addition, 10,000 tons of Inia were imported from Algeria (ref. 7). In total, this is the largest seed import recorded in this publication.

[4] Includes Mexipak, Jori 69c (irrigated area), and Inia 66 (rainfed areas).

[5] This is an enormous increase in HYV area over 1970/71—almost too large to believe. Yet it is possible considering the quantity of seed imported and assuming a seeding rate of about 75 kilo/ha.

[6] The reason for the drop in HYV area from 1971/72 to 1972/73 was not clear at press time. A substantial increase in area is expected during the 1973/74 crop year.

REFERENCES

(1) Abdul Hafiz, "Report on Cereal Improvement and Production in Iraq," FAO, Cairo, April 1971, p. 7.

(2) Foreign Agricultural Service Aircom from Rawalpindi to Program Compliance Division, Export Marketing Service, November 20, 1969.

(3) Letters from Abdul Hafiz, Project Manager, Regional Project, Field Food Crops, FAO, Cairo, December 6, 1973 and January 28, 1974.

(4) Abdul Hafiz, "Impact, Problems, and Potential of the Green Revolution," *Cereal Improvement and Production*, Information Bulletin, Near East Project, FAO, Jan./Apr., and May/Aug., 1973, p. 19.

(5) Telegram from Hafiz, *op. cit.,* April 5, 1974.

(6) Letter from John D. Jacobs, Assistant Agricultural Attache, American Embassy, Mexico City, February 12, 1974.

(7) Letter from Hafiz, *op. cit.,* March 25, 1974.

Table 9—Jordan: HYV wheat seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested	
	Metric tons	*Hectares*	*Acres*
1968/69		90	230[1] (1)
1969/70		100	250[1] (2)
1970/71		120	300[1] (2)
1971/72		140	350[2] (3)
1972/73		150	380[2] (3)

[1] "Improved" wheat varieties.
[2] Predominantly a locally developed variety, Deir Alla No. 1.

REFERENCES

(1) Department of State Airgram TOAID A-363 from Amman, November 28, 1969, p. 3.
(2) Letter from William Horbaly, Agricultural Attache, American Embassy, Beirut, December 1, 1971.
(3) Letter from Shackford Pitcher, Agricultural Attache, American Embassy, Beirut, November 20, 1973.

Table 10—Lebanon: HYV wheat seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested	
	Metric tons	*Hectares*	*Acres*
1967/68		50	124 (1)
1968/69		400	990[1] (2)
1969/70		2,500	6,200[1] (2)
1970/71		7,000	17,300 (2)
1971/72		12,000	29,700 (2)
1972/73		20,000	49,400 (2)

[1] Mexipak.

REFERENCES

(1) Abdul Hafiz, "Impact, Problems and Potential of the Green Revolution," *Information Bulletin*, Cereal Improvement and Production, Near East Project, FAO, Jan./April and May/Aug., 1973, p. 19.
(2) Estimate provided by Dr. Kingma of the Arid Lands Regional Agricultural Program, Ford Foundation, Beirut; forwarded in letter from Shackford Pitcher, Agricultural Attache, American Embassy, Beirut, November 21, 1973.

Table 11—Nepal: HYV wheat seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested	
	Metric tons	Hectares	Acres
1965/66		1,400	3,500[8] (1)
1966/67	38[1] (1)	6,600	16,200[9] (1)
1967/68	450[2] (1)	24,800	61,300[10] (1)
1968/69	7[3] (2)	53,800	132,900[11] (2)
1969/70	300[4] (2)	75,500	186,600[11] (2)
1970/71	136.5[5] (2)	98,200	242,700[11] (2)
1971/72	1,200[6] (3)	115,900	286,450[11] (3)
1972/73	1,638[7] (3)	170,300	420,700[11] (3)

[1] Lerma Rojo. Imported from Mexico by India.

[2] Lerma Rojo, from India.

[3] S-331 from India.

[4] S-227 from India.

[5] 136 M.T. of S-227 from India and 0.52 M.T. Chenab-70 from Pakistan.

[6] 950 M.T. of S-227; 100 M.T. of RR-21; and 150 M.T. of S-331. All from India.

[7] 915 M.T. of RR-21; 300 M.T. of RR-21 foundation seed; 390 M.T. of S-227; 30 M.T. of UP 301; and 3 M.T. of S-331. All from India.

[8] Lerma 52.

[9] 14,800 acres of Lerma 52 and 1,400 of Lerma Rojo.

[10] 31,600 acres of Lerma 52 and 29,700 of Lerma Rojo.

[11] All improved wheat planted.

REFERENCES

(1) Department of State Airgram TOAID A-404 from Kathmandu, February 16, 1968.

(2) Letter from Raymond E. Fort, Food and Agriculture Division, USAID Kathmandu, October 13, 1971 (data from Economic and Planning Division, Ministry of Food and Agriculture).

(3) Letter from Philip D. Smith, Chief, Food and Agriculture Division, USAID, Kathmandu, October 17, 1973 (seed import data from the Agricultural Marketing Corporation; HYV area from Department of Agriculture).

Table 12—Pakistan: HYV wheat seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested		
	Metric tons	*Hectares*	*Acres*	
1965/66	350[1] (1) (2)	4,900	12,000	(1)
1966/67	50[2] (1) (2)	101,200	250,000	(1)
1967/68	42,000[3] (1) (2)	957,100	2,365,000	(3)
1968/69		2,387,700	5,900,000	(4)
1969/70		2,681,500	6,626,000[4]	(5)
1970/71		3,128,300	7,730,000	(6)
1971/72		3,286,200	8,120,000[5,6]	(6)
1972/73		3,338,800	8,250,000[5]	(6)

[1] 250 M.T. of Penjamo 62 and 100 M.T. of Lerma Rojo 64.

[2] Mostly Mexipak 65 (white—Siete Cerros); some Mexipak Red (Indus 66). In addition, 20 M.T. were available locally.

[3] 40,000 M.T. of Mexipak Red (Indus 66) and 2,000 M.T. of Mexipak 65 (Siete Cerros).

[4] Of the total area, about 81 percent was Mexipak, 12.5 percent Indus 66, 4 percent Norteno 67, and 1 percent Inia 66 (ref. 7).

[5] The distribution of this area by province was:

	Punjab	*Sind*	*NWFP*	*Baluchistan*	*Total*
			Percent		
1971/72	75	16	8	1	100
1972/73	74	16	9	1	100

[6] Mexipak continued to be the dominant variety. Newer varieties being grown extensively include Pakistan 20, Chenab 70, Barani 70, SA-42, Khushal 60, and Khushal 69 (ref. 8).

REFERENCES

(1) *Rice and Wheat in Pakistan,* Spring Review (AID), March 17, 1969, pp. 3-5.
(2) *1966-67 CIMMYT Report*, pp. 64-65; Cannon, *op. cit.,* p. 90.
(3) "Country Field Submission: Pakistan, FY 1971," AID, August 1969, Appendix A, Table 1.
(4) Foreign Agricultural Service Report PK0003 from Rawalpindi, January 20, 1970, p. 4.
(5) Foreign Agricultural Service Telegram TOFAS 02 from Islamabad, January 5, 1972.
(6) Data provided by S. M. A. Jafri, Statistical Officer, Planning Unit, Ministry of Agriculture and Works, Agriculture Wing, Islamabad, December 5, 1973.
(7) *1969-70 CIMMYT Report*, p. 90.
(8) *CIMMYT Annual Report*, 1972, p. 50.

Table 13—Syria: HYV wheat seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested	
	Metric tons	*Hectares*	*Acres*
1970/71	5,160[1] (1)	38,000	94,000[2] (2)
1971/72		75,000	185,300[2] (3)
1972/73		180,000	444,800[2,3] (4)

[1] The varietal composition was as follows: Siete Cerros, 1,870 M.T.; Inia, 1,150; Pitic 62, 770; Lerma Rojo, 740; Mexipak 65, 540; and Penjamo 62, 90. Origin not indicated.

[2] The distribution of HYV area between irrigated and rainfed land was as follows:

	Irrigated	*Rainfed*	*Total*
		Percent	
1970/71	66	34	100
1971/72	33	67	100
1972/73	44	56	100

[3] Mainly Pitic 62 and Siete Cerros.

REFERENCES

(1) Abdul Hafiz, "Report on Cereal Improvement and Production in Syria," FAO, Cairo, July 1971, p. 6.

(2) Abdul Hafiz, "Present Status of Wheat Research and Production Programmes in the Near East Region," FAO, Cairo, September 1971, Table III.

(3) Estimate provided by Dr. Kingma of the Arid Lands Regional Agricultural Program, Ford Foundation, Beirut; forwarded in Foreign Agricultural Service Telegram TOFAS 22, April 23, 1974.

(4) Estimate provided by Dr. Kingma; forwarded in Telegram 3251 from Agricultural Attache, American Embassy, Beirut, March 21, 1974.

Table 14—Turkey: HYV wheat seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested	
	Metric tons	*Hectares*	*Acres*
1966/67	60[1] (1)	600	1,500 (1)
1967/68	22,100[2] (2)	170,000	420,000 (2)
1968/69		579,000	1,430,700[3] (3)
1969/70		623,000	1,539,400[4] (3)
1970/71		640,000	1,581,400[5] (3)
1971/72		650,000	1,606,200[6] (3)
1972/73		NA	NA[7]

[1] Sonora 64.

[2] Only 17,000 M.T. planted in fall; remainder planted in spring 1968. Included: 6,190 tons of Lerma Rojo 64; 6,950 of Penjamo 62; and 5,860 of Super X.

[3] In addition, about 18,000 acres were planted to Bezostaya, a high-yielding Russian winter wheat, 100 M.T. of which were first imported in the fall of 1967 (ref. 5).

[4] This figure may be too high (an earlier estimate was 1,343,000 acres) (ref. 4). In addition, about 171,000 acres were planted to HYV's in the winter wheat region (161,500 Bezostaya and 9,500 Wasner; Wasner is an improved American variety imported in 1967) (ref. 5).

[5] This figure also may be too high (an earlier estimate was 1,258,000 acres—see ref. 7). The HYV's in the spring wheat area were composed of both Mexican and Italian types. Early estimates of the Mexican area ranged from 1,184,000 to 1,210,800 acres (refs. 7 and 8), meaning that the area composed of Italian varieties was in the 47,000 to 74,000-acre range. The varietal composition of the Mexican varieties was: Penjamo 89 percent, Lerma Rojo 9 percent, Super X 1 percent, and Pitic 1 percent (ref. 6). In addition, 710,800 acres were reported planted to HYV's in the winter wheat region—619,000 Bezostaya and 91,800 Wasner (ref. 9).

[6] Mexican and Italian spring wheat varieties. Penjamo 62 predominated, occupying 90 percent of the Mexican wheat area, which in turn accounted for 50 to 60 percent of the spring wheat area. Bezostaya occupied about 60 percent of the winter wheat in Thrace, the European area of Turkey (ref. 10).

[7] Official estimates of 1972/73 area were not available as of April 1974 (ref. 11). An unofficial estimate suggests little change in HYV area from 1971/72 (ref. 12). One source indicated that improved wheats occupied about 60 percent of the total spring wheat area; in turn, Penjamo 62 was grown on more than 90 percent of this area (ref. 13). Bezostaya continued very popular in Thrace and occupied 70 percent to 80 percent of the total wheat area in this region; in the latter case the area would have been about 790,700 acres (refs. 11 & 13).

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(1) *1966-67 CIMMYT Report*, p. 69; *CIMMYT Report, 1967-68*, p. 59; Joseph R. Williams, "Wheat Program Leads Off Turkey's New 5-Year Plan," *Foreign Agriculture*, November 20, 1967, p. 5.

(2) *Wheat in Turkey*, Spring Review (Airgram TOAID A-141 from Ankara, March 21, 1969), pp. 5-6, 12-13. (Also see L. M. Humphrey, *Mexican Wheat Comes to Turkey*, USAID, Ankara, April 1969.)

(3) Letter from William L. Davis, Agricultural Attache, American Embassy, Ankara, November 16, 1973.
(4) Harvey P. Johnson, *High-Yielding Winter Wheat for Turkey—A Progress Report*, USAID, Ankara, August 1971, pp. 1, 8.
(5) Abdul Hafiz, "Present Status of Wheat Research and Production Programmes in the Near East Region," FAO, Cairo, September 1971. Table III.
(6) Letter and enclosure from Keith M. Byergo, Deputy Food and Agriculture Officer, USAID, Ankara, October 12, 1971.
(7) Department of State Airgram TOAID A-489 from Ankara, December, 20, 1971, pp. 3, 4.
(8) Letters from William L. Davis, Agricultural Attache, American Embassy, Ankara, September 22, 1971, Janaury 4, 1972.
(9) Abdul Hafiz, "Report on Cereal Improvement and Production in Turkey," FAO, Cairo, July 1971, p. 10.
(10) *CIMMYT Annual Report, 1972*, pp. 55, 57.
(11) Department of State Telegram 2530 from Ankara, April 4, 1974.
(12) Estimate provided by Dr. Kingma of the Arid Lands Regional Agricultural Program, Beirut; forwarded in Foreign Agricultural Service Telegram TOFAS 22, April 23, 1974.
(13) "Wheat Research and Production in Turkey, 1972-73," Wheat Research and Training Center (The Rockefeller Foundation) Ankara, pp. 1-3. (Draft of annual summary for CIMMYT provided by Bill C. Wright, Agricultural Project Leader, January 23, 1974.)

AFRICA

African coverage is limited to three nations in northwest Africa. And there it is largely confined to bread wheats (durum wheats are also raised in this region and are particularly important in Tunisia).

Although an effort was made to locate information on high-yielding wheats elsewhere in Africa, it was generally unsuccessful. The only exception may be Ethiopia where the 45,000 hectares (112,000 acres) of improved wheat planted in 1972 included some Italian and Mexican varieties.[5] It is possible that some of the improved varieties raised in Kenya share a common ancestry with certain early Mexican varieties.[6] In Egypt, a local improved variety known as Giza 155 accounts for about 90 percent of the total area; small areas have been planted to Mexican varieties and some crosses have been made between the two. Giza varieties are also planted in the Sudan.[7] Mexican varieties are being used in breeding and seed multiplication programs elsewhere in Africa such as in Tanzania,[8] but as yet no data seem to be available on commercial plantings.

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[5] Letter from Abdul Hafiz, Project Manager, Regional Field Food Crops Project, Food and Agriculture Organization, Cairo, December 6, 1973.

[6] I have in mind the selections from Kenya which were used in some of the early breeding programs in Mexico. Kentana, for instance, resulted from a Kenya–Mentana cross. See Stakman, *et al., op. cit.*, pp. 84, 85 for details.

[7] Hafiz, *op. cit.;* H. S. El-Tobgy and Elham Talaat, "Wheat Improvement and Production in Egypt," *Proceedings of the First Wheat Workshop*, CIMMYT, September 1971, p. 25; Fathi Salim, "Local Egyptian Wheat Found Superior to Newly Developed Mexican Strain," *Akhbar al-Yawm*, Cairo, August 21, 1971, p. 3 (translation in JPRS 54156, September 29, 1971).

[8] In Tanzania, the Lyamungu Research Station made 270 M.T. of seed with Mexican parentage available in 1973: 180 M.T. of W-3503, Trophy (T-K^2 X Y 50) and 90 M.T. of W-3654, Inia sib (letter from Henry C. Wiggin, USAID, Dar es Salaam, November 15, 1973).

Table 15—Algeria: HYV wheat seed imports and area planted or harvested

Crop year	Quantity of seed imported		Area planted or harvested		
	Metric tons		Hectares	Acres	
1969/70	1,500[1]	(1)	5,100	12,600	(4)
1970/71	17,000[2]	(2)	140,000	346,000[4]	(2)
1971/72			320,000	790,700[5]	(4)
1972/73	15,468[3]	(3)	600,000	1,482,600[6,7]	(5) (6)
(1973/74)			(850,000)	(2,100,000)[6,8]	(5)

[1] Principally from Mexico. Substantial quantities of seed were also imported from Morocco and Tunisia.

[2] In 1970, Mexico exported 11,182 M.T. of seed to Algeria; the business was handled by a Swiss firm, however, and the exports are listed as going to Switzerland in the official Mexican statistics (ref. 7).

[3] Reported export of seed from Mexico to Algeria in 1972.

[4] Seed supplies were sufficient for 365,700 acres, but some arrived late. About 341,000 acres were planted to Mexican varieties (Inia 66, Siete Cerros, and Tobari) and 4,940 to Italian varieties.

[5] Inia 66, Siete Cerros, Tobari, and Strampelli.

[6] Principally used in the socialist sector.

[7] About 80 percent bread wheats and 20 percent durums. Within the bread category the varietal breakdown was: Siete Cerros 70 percent, Inia 25 percent, and Tobari 5 percent. The durum variety was Jori C69. Strampelli performed as well as Siete Cerros, but was still under seed multiplication.

[8] Average of projection range.

REFERENCES

(1) Conversation with Dr. Gregorio Martinez of CIMMYT, December 17, 1970.

(2) *CIMMYT Annual Report, 1970/71*, p. 51.

(3) Letter from Richard A. Smith, Agricultural Attache, American Embassy, Mexico City, January 18, 1974 (data from Director General of Statistics, Secretariat of Industry and Commerce).

(4) *CIMMYT Annual Report*, 1972, p. 70.

(5) Zhor Zerari, "Cereal Production Set Back by Bad Weather" (in French), *Algerie-Actualite*, Algiers, July 1973, p. 8.

(6) Letter from W. L. McCuistion, Project Cereales-CIMMYT, Algiers, January 28, 1974.

(7) Letter from John D. Jacobs Assistant Agricultural Attache, American Embassy, Mexico City, February 12, 1974.

Table 16—Morocco: HYV wheat seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested		
	Metric tons	*Hectares*	*Acres*	
1967/68	1[1] (1)	200	500	(2)
1968/69	500[2] (3) (4)	4,900	12,100[3]	(3)
1969/70		46,500	114,900[4,5]	(4)
1970/71		90,000	222,400[4,5]	(4)
1971/72		206,000	509,000[4,5]	(4)
1972/73		294,000	726,500[4,5]	(4)
(1973/74)		(400,000)	(988,400)[4,5]	(4)

[1] Siete Cerros (plus 150 kg of Super X).

[2] Included 250 M.T. of Siete Cerros, 100 of Inia 66, 100 of Tobari 66, 25 of Penjamo 62, and 25 of Norteno.

[3] 50 percent Siete Cerros; rest Inia 66, Tobari 66, and Penjamo 62 (ref. 6).

[4] Unofficial estimate made by U.S. Agricultural Attache based on quantities of certified seed available, discussions with USAID agriculturists, and other information.

[5] The estimated breakdown by variety was as follows:

	908 (Italian)	*Siete Cerros*	*Tobari*	*Total*
		Percent		
1969/70	44	32	25	100
1970/71	95	3	2	100
1971/72	91	7	—	100
1972/73	95	5	—	100
(1973/74)	91	9	—	100

REFERENCES

(1) Department of State Airgram A-272 from Rabat, December 26, 1967.

(2) *CIMMYT Report, 1967-68*, p. 73.

(3) *Morocco: Wheat*, Spring Review (AID), March 13, 1969, pp. 2, 4.

(4) "Moroccan Agriculture Thrives on High-Yield Mexican Wheat," *Front Lines* (AID), February 15, 1969, p. 3.

(5) Foreign Agricultural Service Telegrams TOFAS 10 and TOFAS 13 from Rabat, March 22 and 27, 1974.

(6) *CIMMYT Report, 1968-69*, pp. 57, 97.

Table 17—Tunisia: HYV wheat seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested	
	Metric tons	*Hectares*	*Acres*
1967/68	50 (1)	800	2,000 (2)
1968/69		12,000	29,700 (3)
1969/70		53,000	131,000 (3)
1970/71		102,000	252,000 (3)
1971/72		60,000	148,300[1] (3)
1972/73		99,000	244,600[2] (3)

[1] The decrease may have been due to dissatisfaction of farmers with the quality of seed distributed during the 1970/71 season (ref. 4).

[2] In addition, another 124,000 acres were sown with locally selected and improved durum varieties (ref. 4). Two, Badri and Inrat, occupied about 25 percent of the durum area in 1973/74. The newer varieties in the testing stage carry the Norin 10 dwarfing genes (ref. 5).

REFERENCES

(1) "Tunisia to Close Wheat Gap," *Front Lines* (AID), December 15, 1968, p. 7.
(2) Foreign Agricultural Service Report TN-9004 from Rabat, June 26, 1969.
(3) Letter from Gaylord L. Walker, Senior Agriculture Sector Advisor, USAID, Tunis, October 19, 1973 (data provided by the Office of Cereals).
(4) Letter for Buford H. Grigsby, Project Officer, Agricultural Production and Research, USAID, Tunis, November 8, 1973.
(5) Letter from George Varughese, CIMMYT, c/o Ford Foundation, Tunis, February 8, 1974.

ADDITIONAL SEED IMPORT DATA

Table 18—Imports of Mexican wheat seed by countries where no planted area data are yet available

Country and crop year	Metric tons	Notes	References
ASIA			
Burma			
1968/69	2	1	(1)
1969/70	302	2	(1) (2)
Saudi Arabia			
1969/70	2	3	(1)
AFRICA			
Sudan			
1969/70	(1)	4	(1)
1970/71	(5)	5	(3)
Tanzania			
1969/70	3	6	(1)
Zambia			
1969/70	0.2	–	(1)
LATIN AMERICA			
Brazil			
1967/68	1,475	7	(4)
1969/70	1	7	(4)
1970/71	1	7	(4)
Guatemala			
1967/68	506	7	(4)
1968/69	1	7	(4)
1969/70	22	7	(4)
1970/71	100	7	(4)
Bolivia			
1968/69	50	1	(5)

[1] Shipped from West Pakistan in September 1968.

[2] Of total, 300 M.T. shipped from West Pakistan in September 1969; 1.5 M.T. shipped from India during July-September 1969 period (1 M.T. of Kalyan Sona; 0.5 M.T. of Sharbati Sonora).

[3] Gift from West Pakistan.

[4] Gift from West Pakistan, shipped September 1969.

[5] Authorization for West Pakistan to export 5 M.T. of Mexipak.

[6] Gift from West Pakistan; shipped June 1969.

[7] Shipped from Mexico.

[8] Two varieties, 25 M.T. each (type not stated, but Jaral 66 and Norteno 67 previously tested).

REFERENCES

(1) Foreign Agricultural Service Aircomm from Rawalpindi to Program Compliance Division, Export Marketing Service, November 20, 1969.

(2) Foreign Agricultural Service Report IN0025 from New Delhi, February 19, 1970.

(3) Department of State Telegram 117861 to Rawalpindi, July 22, 1970.

(4) Letter from Richard A. Smith, Agricultural Attache, American Embassy, Mexico City, January 18, 1974 (data from Director General of Statistics, Secretariat of Industry and Commerce).

(5) Department of State Telegram 5196 from La Paz, June 21, 1968; Airgram A-802 from La Paz, July 3, 1968.

IV. HIGH-YIELDING RICE VARIETIES

This chapter summarizes data on area of high-yielding varieties of rice planted or harvested, and fragmentary information on seed imports, for developing nations in Asia, Africa, and Latin America. Each of the continents is handled somewhat differently.

The Asian portion follows the format used in the previous chapter on wheat. A separate table is provided for each of 13 nations. Data which are particularly tentative or which are preliminary estimates for the 1973/74 season are placed in parentheses. Data are generally rounded to the nearest hundred; consequently, hectare and acre figures do not convert precisely. Available information on rice improvement in the People's Republic of China and North Vietnam is summarized in the Appendix.

Only scattered preliminary observations are available for Africa. These are summarized in a short essay.

Some estimates are beginning to become available for Latin America. Data for 1971/72 and 1972/73 for 11 nations are summarized in one general table. The table is both derived differently and arranged in a different format from that used elsewhere in the report. An introductory note describes the procedure utilized.

A final section summarizes seed exports from the Philippines—both by IRRI and private firms—to 15 nations, aside from those listed in the Asian country tables through 1970. Virtually all of the data on imports of Philippine seed cited in this table, and elsewhere in this chapter, were provided by Dr. Randolph Barker of IRRI. Most of these statistics were supplied through correspondence in October 1970; the reference to this data in the country tables reads simply "Barker (October 1970)." In addition, reference is made to an article by Dr. Barker, "Economic Aspects of High-Yielding Varieties of Rice, With Special Reference to National Price Policies," in the *Monthly Bulletin of Agricultural Economics and Statistics,* June 1969, pp. 1-2; it is noted as "Barker (June 1969)."

Table 19—Bangladesh: HYV rice seed imports and area planted or harvested

Crop year	Quantity of seed imported		Area planted or harvested	
	Metric tons		Hectares	Acres
1966/67	10	(1)	200	500 (2)
1967/68	1,500[1]	(1)(2)	67,200	166,000 (5)
1968/69			152,200	376,000[5] (6)
1969/70	4.4	(3)	263,900	652,000[5] (6)
1970/71	1,800[2]	(3)	460,100	1,137,000[5] (6)
1971/72			623,600	1,541,000[5] (7)
1972/73	7,000[3]	(4)	1,069,600	2,643,000[5] (8)
(1973/74)	5,200[4]	(4)		

[1] IR-8 planted during boro (winter) season.

[2] IR-20 received from commercial sources in the Philippines.

[3] "In 1972, the Bangladesh Government imported about 7,000 M.T. of IR-20 seed from the Philippines, which is the largest consignment of rice seeds ever imported by any country" (ref. 4).

[4] IR-20 exported from the Philippines in 1973.

[5] The approximate seasonal distribution of the IRRI varieties was:

Crop year	*Aus* (spring-summer)	*Aman* (summer-fall)	*Boro* (winter)	*Total*
		Percent		
1968/69	4.4	0	95.6	100
1969/70	6.6	4.5	88.9	100
1970/71	7.6	17.6[a]	75.4	100
1971/72	7.7	40.6[b]	51.6[d]	100
1972/73	6.2	52.2[c]	41.6	100

[a] Of a total 199,800 acres, 166,500 or 83 percent were IR-20. (Details on the introduction and use of IR-20 are provided in reference 9.)

[b] Of a total 625,600 acres, 568,700 or 91 percent were IR-20.

[c] Of a total 1,378,600 acres, 1,259,700 or 91 percent were IR-20.

[d] Of a total 795,400 acres, about 148,260 or 18 percent were planted to Chandina (ref. 4, pp. 157, 235).

REFERENCES

(1) Letter from Leon F. Hesser, Assistant Director of Agricultural Policy, USAID, Rawalpindi, October 9, 1969.

(2) *Rice and Wheat in Pakistan,* Spring Review (AID), March 17, 1969, pp. 2-5.

(3) Barker (October 1970). Also see Foreign Agricultural Service Report PK 1032 from Islamabad, May 14, 1971.

(4) *IRRI Annual Report for 1972,* p. 1 (source of quote); data provided by Randolph Barker of IRRI, January 1974.

(5) "Country Field Submission: Pakistan, FY 1971," AID, August 1969, Appendix A, Table 1; letter from Carl O. Winberg, Agricultural Attache, American Embassy, Rawalpindi, October 7, 1969.

(6) Foreign Agricultural Service Report BD-3012 from Dacca, April 18, 1973 (enclosing mimeographed report from Bureau of Agricultural Statistics, Directorate of Agriculture).

(7) Foreign Agricultural Service Reports from Dacca: BD-3019, May 4, 1973 (enclosing clipping from *The Bangladesh Gazette,* November 30, 1972); BD-3034, June 29, 1973 (enclosing UNROD Report, December 1972, p. 14); and BD-3035, July 17, 1973 (enclosing clipping from *The Bangladesh Gazette,* June 28, 1973).

(8) Foreign Agricultural Service Reports from Dacca: BD-3007, April 3, 1973 (enclosing addendum to UNROD Report, March 27, 1973); BD-3035, *op. cit.* Letter from Carl Winberg, Agricultural Attache, American Embassy, Dacca, October 15, 1973 (aus data provided by Joint Secretary, Development, Ministry of Agriculture).

(9) Foreign Agricultural Service Report PK 1035 from Islamabad, May 21, 1971 (enclosure by Refugio I. Rochin on "Farmer's Experiences with IR-20 Rice Variety and Complementary Production Inputs: East Pakistan, Aman-1970." May 1971, 35 pp., subsequently published in *The Bangladesh Economic Review,* January 1973, pp. 71-94). Buford H. Grigsby, "Introduction of IR-20 Rice Into East Pakistan," USAID, Dacca, January 14, 1972, 12 pp.

Table 20—Burma: HYV rice seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested	
	Metric tons	*Hectares*	*Acres*
1966/67	0.1[1] (1)	Neg	19[6] (3)
1967/68	200 [2] (1)	3,400	8,500[6] (3)
1968/69	– [3] (2)	166,900	412,400[7] (3)
1969/70	200 [4] (2)	143,000	353,300[8] (4)
1970/71	100 [5] (2)	190,900	471,800[9] (4)
1971/72		185,100	457,300[8] (4)
1972/73		199,200	492,200[8] (4)

[1] IR-8 imported from IRRI in 1966.
[2] IR-8 imported from the Philippines in 1967.
[3] IR-8, IR-5; less than 0.1 M.T. of each imported from IRRI in 1968.
[4] IR-5 imported from the Philippines in 1969.
[5] IR-20 imported from the Philippines in 1970.
[6] IR-8.
[7] IR-8; in addition, 60 acres of Ngwetoe, an improved local variety, were planted.
[8] The approximate varietal compostion by season was as follows:

	*Yagyaw 1** *(IR-8)*	*Yagyaw 2*** *(IR-5)*	*C-4/63***	*Ngwetoe***	*Total*
			Percent		
1969/70	90.3	3.3	–	6.4	100
1970/71	5.3	86.1	0.3	8.3	100
1971/72	2.6	76.9	13.1	7.4	100
1972/73	1.8	72.9	17.7	7.5	100

*Sown area.
**Harvested area. Ngwetoe is an improved local variety.

IR-8 was not accepted by farmers or producers. C-4/63 is considered well adapted to growing conditions in upper Burma and is expected to partly replace IR-5 there. IR-20 ("Shwewarhnan"), IR-22 ("Lonethweshwewar"), and IR-24 ("Shwewaryint") were, as of August 1973, shortly to be released to farmers. An improved strain of IR-5 has been produced by irradiation and is to be distributed in lower Burma (ref. 6).

REFERENCES

(1) Barker (June 1969). Also Gladys Charitz, "Rice Surplus Affirms Success," *Journal of Commerce,* March 29, 1968.
(2) Barker (October 1970).
(3) Official sources, August 4, 1970.
(4) *Report to the People, 1972-73,* Rangoon, 1973, part IV, ch. 1, par. 56; official sources, October 18, 1973.
(5) Moe Myint, "A Welcome by Emerald-Green Fields—3," *Working People's Daily,* Rangoon, August 10, 1973.
(6) "Agri Research Produces Better Quality Rice," *The Guardian,* Rangoon, October 12, 1973.

Table 21—India: HYV rice seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested		
	Metric tons	*Hectares*	*Acres*	
1964/65	–[1] (1)	90	200 [8]	(4)
1965/66	6[2] (1)	7,100	17,650 [9]	(1)
1966/67	80[3] (1)	888,400	2,195,200 [10]	(5)
1967/68	20[4] (2)	1,785,000	4,410,700 [10]	(5)
1968/69	–[5] (3)	2,681,000	6,624,800 [10,11,12]	(5)
1969/70	–[6] (3)	4,343,500	10,732,700 [12]	(5)
1970/71	–[7] (3)	5,589,200	13,811,000 [12]	(5)
1971/72		7,411,400	18,313,600 [12]	(5)
1972/73		8,639,100	21,347,200 [12]	(5)
(1973/74)		(10,162,200)	(25,110,900)[12,13]	(5)

[1] Taichung (Native)-1, hereinafter noted as TN-1. Two kg were taken to India in a suitcase by the manager of the National Seeds Corporation.

[2] TN-1. One M.T. was shipped by air freight from IRRI in June 1965. Another 5 M.T. were received by ship from Taiwan in October 1965.

[3] TN-1. Gift of Joint Commission for Agricultural Reconstruction in Taiwan.

[4] IR-8 (from IRRI). Ten M.T. were provided by the Ford Foundation and arrived in mid-December 1966. The other 10 M.T. were provided by the Rockefeller Foundation and arrived in Calcutta in February 1967.

[5] Less than 0.1 M.T. of IR-5 from IRRI in 1968.

[6] Import of less than 0.1 M.T. each of IR 5-81 and IR 5-114 from IRRI in 1969. (Neither is an official variety, but rather a selection.)

[7] Import of less than 0.1 M.T. each of IR-20 and IR-22 from IRRI in 1970.

[8] ADT-27.

[9] Composed of 2,500 acres of ADT-27 and 15,150 acres of TN-1. Of the ADT-27 area, 15,000 acres were in the rabi (winter) season and 150 in the kharif (summer) season.

[10] The approximate seasonal distribution was:

Crop year	*Rabi (winter)*	*Kharif (summer)*	*Total*
		Percent	
1966/67	43	57	100
1967/68	38	62	100
1968/69	29	71	100

[11] Within the rabi season, IR-8 accounted for about 49 percent of the 1,935,000 acres harvested, TN-1 22 percent, and ADT-27 and others 28 percent (ref. 6).

[12] The distribution of this area by state was:

	Tamil Nadu	*Andhra Pradesh*	*West Bengal*	*Uttar Pradesh*	*Others*	*Total*
			Percent			
1966/67	17.2	31.0	3.0	7.8	41.1	100
1967/68	24.8	19.6	7.3	8.4	39.9	100
1968/69	23.8	7.6	10.0	12.3	46.2	100
1969/70	26.3	12.0	10.6	12.9	38.2	100
1970/71	32.5	9.7	9.8	12.1	35.9	100
1971/72	30.3	9.8	9.5	13.4	37.0	100
1972/73	26.0	13.9	7.0	10.7	42.5	100
(1973/74)	(22.1)	(11.8)	(11.8)	(10.0)	(44.3)	100

[13] Total of state targets. The Government of India target was 24,710,000, and may be exceeded. Preliminary estimates suggest that the total of the state targets was approximately reached.

REFERENCES

(1) Carroll P. Streeter, *A Partnership to Improve Food Production in India,* The Rockefeller Foundation (undated: 1969 or 1970), pp. 26-29.

(2) *Ibid.*; letter from Streeter, April 14, 1970; letter from Randolph Barker, IRRI, March 31, 1970.

(3) Barker (October 1970).

(4) "Rice Crop Proves Tanjore Program's Worth," *Foreign Agriculture,* March 4, 1968, p. 7; Department of State Airgram A-44 from Madras, October 13, 1967.

(5) Unpublished data from the Ministry of Agriculture, forwarded by Horace Davis, Agricultural Attache, American Embassy, New Delhi, on October 19 and December 13, 1973. (Subsequently included in FAS Report IN4002 from New Delhi, January 4, 1974.) Estimates for 1969/70 and 1970/71 are very similar to those presented in "Report on Price Policy for Kharif Cereals for the 1971-72 Season," Agricultural Prices Commission, New Delhi, September 1971, Table 4.

(6) "Evaluation Study of High-Yielding Varieties Programme, Report for the Rabi 1968-60—Wheat, Paddy, and Jowar," Planning Commission, New Delhi, November 1969, p. 50.

Table 22—Indonesia: HYV rice seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested	
	Metric tons	*Hectares*	*Acres*
1966/67	0.2[1] (1)	–	–
1967/68		–	–
1968/69	1 [2] (2)	198,000	489,000[7] (5)
1969/70		826,000	2,041,000[7] (5)
1970/71	– [3] (3)	913,000	2,256,000[7] (5)
1971/72		1,338,000	3,306,000[7] (5)
1972/73	1 [4] (4)	1,521,000	3,758,000[7] (6)

[1] 200 kg (440 lbs.); introduced from IRRI in 1966. "There have been additional imports of small lots of seed but they have probably not exceeded one metric ton" (ref. 1).

[2] C4-63; developed at the College of Agriculture at the University of the Philippines; imported in first 6 months of 1968 (ref. 3).

[3] 100 kg (220 lbs.) each of IR-20 and IR-22 were introduced in January 1969 and February 1970, respectively, with USAID assistance.

[4] One metric ton of IR-20 from IRRI.

[5] Includes only area under government programs. In addition, substantial areas are voluntarily planted outside of program areas. Field observations in 1973 suggested that this variety area is roughly half as large as that in government programs (ref. 7).

[6] Includes all high-yielding varieties: IR-5 and IR-8 (known locally as Peta Baru-5 and Peta Baru-8), C4-63, Pelita I/1, and Pelita I/2. Widespread use of the IRRI varieties began during the 1968/69 wet season (ref. 8) while C4-63 came into commercial planting during 1969/70 (ref. 3).

[7] The seasonal distribution was as follows:

Crop year	*Dry* (Apr.-Sept.)	*Wet* (Oct.-Mar.)	*Total*
	Percent		
1968-69	9.1	90.9	100
1969-70	36.4	63.6	100
1970-71	28.4	71.6	100
1971-72	32.1	67.9	100
1972-73	33.1	66.9	100

REFERENCES

(1) Letter from Francis J. LeBeau, Chief, Agriculture Division, USAID, Djakarta, September 30, 1969 (data obtained from Ministry of Agriculture of the Government of Indonesia).

(2) Barker, *op. cit.*, (June 1969).

(3) James E. Hawes, "Rice in Indonesia," Agriculture Division, USAID, Djakarta, May 1970, pp. 18, 19.

(4) Letter from Paul J. Stangel, Acting Food and Agriculture Officer, USAID, Djakarta, December 21, 1973 (data provided by the Director General of Agriculture).

(5) "Paddy Intensification Program: Indonesia," p. 15 (data provided by Badan Pengendali Bimas, Department of Agriculture and forwarded by Peter Oram of FAO).

(6) N. M. Idaikkadar, "Crop Statistics for Indonesia, 1955-1972," FAO, August, 1973, p. 15, Table 14 ("Paddy Intensification Program"). Data from Badan Pengendali Bimas, Department of Agriculture, and forwarded by Peter Oram and B. N. Webster of FAO.

(7) Discussion with Myron Smith, former Food and Agriculture Officer, USAID, Djakarta, Washington, December 21, 1973. Also see Leon Hesser, "Indonesia Agricultural Sector Assessment," USAID, October 1973 (1st draft), Annex II, Table 2. fn.

(8) Kampto Utomo, "Indonesia," *Regional Seminar on Agriculture: Papers and Proceedings,* Asian Development Bank, Manila, 1969, p. 161.

Table 23—Korea (South): HYV rice seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested		
	Metric tons	*Hectares*	*Acres*	
1970/71		experimental		
1971/72		2,700	6,700	(1)
1972/73		187,000[1]	462,000[1]	(1)

[1] Tongil was planted in a number of areas which were geographically unsuited for the variety. This plus an unfavorable growing season and other factors led to a number of problems. Farmers were subsidized (see ref. 2 for details). Area in 1973/74 is likely to be less.

REFERENCES

(1) Letter from Clancy V. Jean, Agricultural Attache, American Embassy, Seoul, October 5, 1973.

(2) Foreign Agricultural Service Report KR-3016 from Seoul, March 14, 1973, 3 pp.; FAS Report KR-2017 from Seoul, March 22, 1972.

Table 24—Laos: HYV rice seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested		
	Metric tons	*Hectares*	*Acres*	
1966/67	0.1[1] (1)	360	900 [4]	(3)
1967/68		1,200	3,000 [4]	(4)
1968/69	6 [2] (1)	2,000	5,000 [4]	(4)
1969/70		2,000	4,900 [4]	(5)
1970/71	10 [3] (2)	(53,600)	(132,500)[4,5]	(6)
1971/72		30,000	74,100 [4]	(7)
1972/73		50,000	123,600 [4]	(7)

[1] IR-8 imported from IRRI in 1966.

[2] Two M.T. each of IR-5 and IR-253 (a glutinous variety specifically bred to suit taste preferences in the upper Mekong River basin) were imported from Philippines in 1968. Two M.T. of IR-253 came from IRRI in 1968.

[3] IR-20 from commercial sources in the Philippines. In addition, less than 0.1 M.T. each of IR-20 and IR-22 were imported from IRRI.

[4] The approximate seasonal distribution was as follows:

	Wet	*Dry*	*Total*
	Percent		
1966/67	–	100	100
1967/68	17	83	100
1968/69	25	75	100
1969/70	25	75	100
1970/71	(97)	(3)	(100)
1971/72	94	6	100
1972/73	96	4	100

[5] The increase in wet season area is exceptionally large. It may represent the theoretical area that could have been planted (ref. 8).

REFERENCES

(1) Barker (June 1969).

(2) Barker (October 1970).

(3) Department of State Airgram A-647 from Vientiane, August 15, 1969.

(4) Letter from Leroy H. Rasmussen, Agriculture Division, USAID, Vientiane, September 12, 1969.

(5) Letter from Rasmussen, September 23, 1970.

(6) Department of State Telegrams from Vientiane: 00476, January 18, 1972 and 00804, January 28, 1972.

(7) Letter from Charles A. Sanders, Chief, Agriculture Division, USAID, Vientiane, October 26, 1973.

(8) Letter from Donald R. Mitchell, Deputy Chief, Agriculture Division, USAID, Vientiane, January 4, 1974.

Table 25—Malaysia (West): HYV rice seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested[5]	
	Metric tons	*Hectares*	*Acres*
1965/66	3[1] (1)	42,300	104,450 (3)
1966/67	3[2] (1)	62,700	155,000 (4)
1967/68		90,700	224,200 [4] (4)
1968/69		96,100	237,500 [4] (4)
1969/70		132,400	327,100 [4] (4)
1970/71	–[3] (2)	164,600	406,600 [4] (4)
1971/72		196,900	486,500 [4] (4)
1972/73		217,300	537,000 (5)
(1973/74)		(233,500)	(577,000) (5)

[1] IR-8 imported from IRRI in 1966.
[2] IR-8 imported from IRRI in 1967.
[3] Less than 1 M.T. each of IR-20 and IR-22 imported from IRRI in 1970.
[4] The varietal breakdown was as follows:

	Bahagia (IR-5 type)	*Mahsuri*	*Malinja*	*Ria* (IR-8)	*Others*	*Total*
			Percent			
1968/69	13.9	63.0	4.9	6.8	11.5	100
1969/70	49.5	39.7	1.1	2.1	7.6	100
1970/71	38.1	30.9	4.8	3.1	23.2	100
1971/72	39.5	45.0	2.0	1.3	12.2	100

[5] Area harvested through 1971/72; planted area in 1972/73 and 1973/74. Off-season (second) wet rice crop. Includes a number of improved hybrids. The main variety through 1968/69 was (a) Mahsuri, which was introduced in January 1965. Other varieties are (b) Malinja, which was introduced in early 1950's; (c) Ria, a local name for IR-8, which was introduced in late 1966; and (d) Bahagia, which originated from the same parental cross as IR-5 and was introduced in 1968. Two more varieties were introduced in 1972: Murni (Bahagia x Ria) and Masria (IR-8 x Muey Nahng 62 M). Padi Jaya (Peta x BPJ 76) was introduced in 1973 (ref. 6).

REFERENCES

(1) Barker (June 1969).
(2) Barker (October 1970).
(3) Letter from Dale K. Vining, Agricultural Attache, American Embassy, Kuala Lumpur, September 4, 1969 (estimate made by Attache's office).
(4) Letters from Gordon S. Nicks, Agricultural Attache, American Embassy, Kuala Lumpur, October 11, 1973 and January 11, 1974.
(5) Foreign Agricultural Service Report MY 3014 from Kuala Lumpur, August 3, 1973.
(6) Foreign Agricultural Service Reports from Kuala Lumpur: AGR-40, March 2, 1964; AGR-36, January 1, 1965; AGR-7, August 19, 1966; AGR-69, September 10, 1968; MY 2009, March 14, 1972; and MY 3017, September 25, 1973.

Table 26—Nepal: HYV rice seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested	
	Metric tons	*Hectares*	*Acres*
1968/69	60.6[1] (1)(2)	42,500	105,100[4] (2)
1969/70	75 [2] (2)	49,800	123,000[4] (2)
1970/71	0.5[3] (1)	67,800	167,600[4] (2)
1971/72		81,600	201,700[4] (3)
1972/73	1 (3)	177,300	438,000[4] (3)

[1] Import of 60 M.T. of IR-8 from India and 0.6 M.T. of IR-5 from IRRI.

[2] Import of 75 M.T. of IR-8 from India.

[3] Import of 0.32 M.T. of IR-20 and 0.19 M.T. of IR-22 from IRRI in 1970 (Nepalese data list the quantities as 0.14 and 0.09 M.T., respectively; ref. 2).

[4] All improved rice.

REFERENCES

(1) Barker (October 1970).

(2) Letter from Raymond E. Fort, Food and Agriculture Division, USAID, Kathmandu, October 13, 1971 (data from Economic Analysis and Planning Division, Ministry of Food and Agriculture).

(3) Letter from Philip D. Smith, Chief, Food and Agriculture Division, USAID, Kathmandu, October 17, 1973.

Table 27—Pakistan: HYV rice seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested		
	Metric tons	*Hectares*	*Acres*	
1966/67	2[1] (1)	80	200[3]	(2)
1967/68	77[2] (1)	4,000	10,000[1]	(2)
1968/69		308,000	761,000[4]	(2)(3)
1969/70		501,400	1,239,000	(4)
1970/71		550,400	1,360,000	(5)
1971/72		728,500	1,800,000[5]	(5)
1972/73		643,500	1,590,000[5,6]	(5)

[1] IR-8.

[2] IR-8; 50 M.T. were imported directly from Los Banos and another 27 M.T. were forwarded from Bangladesh where they were produced during the 1966/67 season.

[3] "Few hundred acres."

[4] Includes a "few thousand" acres of "IR-6" (Mehran 69) in the Hyderabad region; this variety is expected to eventually replace IR-8 (ref. 6).

[5] The distribution of production by province was:

	Sind	*Punjab*	*Baluchistan*	*NWFP*	*Total*
			Percent		
1971/72	68.6	28.6	2.1	0.7	100
1972/73	77.0	20.5	1.6	0.8	100

Almost entirely "IR-6" (Mehran 69)—ref. 7.

[6] The decline in area in 1972/73 was due, according to one report of the Ministry of Food and Agriculture, to "secession of East Pakistan causing fears of lower demand for this variety of rice." The area was expected to increase in 1973/74 because of an increase in the export price and demand for export. Others point out that the present price support level favors the production of Basmati rice for export.

REFERENCES

(1) "Rice and Wheat in Pakistan," Spring Review (AID), March 1969, pp. 16-17.

(2) Letter from Leon F. Hesser, Assistant Director of Agricultural Policy, USAID, Rawalpindi, October 9, 1969.

(3) Foreign Agricultural Service Telegram TOFAS 96 from Rawalpindi, October 15, 1969

(4) "Notification," Government of Pakistan, Ministry of Agriculture and Works, Islamabad, November 11, 1970, p. 1 (enclosure to Foreign Agricultural Service Report PK 0091 from Islamabad, November 24, 1970).

(5) Data provided by S. M. A. Jafri, Statistical Officer, Planning Unit, Ministry of Agriculture and Works, Agriculture Wing, Islamabad, December 5, 1973.

(6) Foreign Agricultural Service Report PK-9095 from Rawalpindi. August 5. 1969.

(7) Letter from Jerry B. Eckert, Colorado State University Water Management Research Project, January 18, 1974.

Table 28—Philippines: HYV rice seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested	
	Metric tons	*Hectares*	*Acres*
1966/67	55.3[1] (1)	82,600	204,100 (3)
1967/68	6.1[2] (1)	653,000	1,613,600[6] (4)
1968/69	18.2[3] (1)	(1,011,800)	(2,500,000)[7]
1969/70	– [4] (2)	1,354,000	3,345,700 [8] (4)
1970/71	34.4[5] (2)	1,565,000	3,867,100 (4)
1971/72		1,827,000	4,514,500 (4)
1972/73		(1,752,000)	(4,329,200)[9] (5)

[1] IR-8 purchased from IRRI in July 1966 and planted in dry season in late 1966 and early 1967.

[2] 5.2 M.T. IR-8 and 0.9 M.T. IR-5 (from IRRI).

[3] 0.1 M.T. IR-8 and 18.1 M.T. IR-5 (from IRRI).

[4] Less than 0.1 M.T. each of IR-8, IR-5, IR-20, and IR-22 from IRRI in 1969.

[5] Composed of 9.5 M.T. of IR-20 and 24.9 M.T. of IR-22, both provided by IRRI in 1970. In addition, less than a M.T. each of IR-8 and IR-5 were also provided by IRRI in 1970.

[6] Bureau of Agricultural Economics (BAE) data. The total was broken down as follows: IR series, 1,082,000 acres; BPI series, 629,000; C series, 9,000. The BPI series was developed by the Bureau of Plant Industry of the Philippine Government; it is not as high yielding as the other two series. The C series was developed by the College of Agriculture at the University of the Philippines.

[7] Unofficial estimate. The original official estimate of the Bureau of Agricultural Economics was 3,155,000 acres (ref. 6), but this seems too high in terms of (a) the figures for the previous and subsequent year (the area devoted to HYV's was to have increased about 20 percent in 1969/70; ref. 6), and (b) another estimate available for the same year. The National Food and Agricultural Council placed the area at 1,432,600 acres (ref. 7), or 41 percent less than the area reported in the table and 53 percent less than the BAE figure just noted). The BAE figure was broken down as follows: IR series, 2,223,000 acres; BPI series, 723,000; and C series, 209,000. The revised BAE estimate is 3,120,900 acres (ref. 4).

[8] Bureau of Agricultural Economics data. The National Food and Agricultural Council places the area at 2,347,500 acres, or about 30 percent less (ref. 8). The BAE data were broken down as follows: IR series, 2,562,900 acres; BPI series, 283,000; and C series, 499,500.

[9] Actual area estimate not available at press time. Preliminary data indicate that the area planted to HYV's was the same proportion of total area as in 1971/72. The total area in that year was 3,246,000 hectares, of which 56.3 percent were planted to HYV's. The total area in 1972/73 was estimated at 3,112,000 hectares, down about 4 percent; thus, the HYV area declined correspondingly.

REFERENCES

(1) Barker (June 1969).

(2) Barker (October 1970).

(3) *Rice in the Philippines,* Spring Review (AID), March 3, 1969, section 2, p. 6, Appendix Table VIII-B. Data from RCPCC.

(4) Official estimates of the Bureau of Agricultural Economics, Quezon City (forwarded by David E. Kunkel, November 7, 1973).

(5) Foreign Agricultural Service Telegram TOFAS 33 from Manila, April 1, 1974.
(6) Telegram from Randolph Barker, IRRI, December 14, 1970; letter from Barker, December 15, 1970.
(7) Letter from John T. Hopkins, Assistant Agricultural Attache, American Embassy, Manila, September 25, 1970.
(8) Foreign Agricultural Service Telegram TOFAS 70 from Manila, December 3, 1970.

Table 29—Sri Lanka (Ceylon): HYV rice seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested	
	Metric tons	*Hectares*	*Acres*
1967/68	0.5[1] (1)	—	—
1968/69	211 [2] (1)	7,000	17,200[5,6] (3)
1969/70	–[3] (2)	26,300	65,100[5,6] (4)(5)
1970/71	0.4[4] (2)	29,500	73,000[5,6] (5)(6)
1971/72		29,600	73,100[5,6] (6)(7)
1972/73		17,600	43,500[5,6] (7)

[1] IR-8 (from IRRI).

[2] IR-8. In 1968, 210 M.T. of IR-8 were imported from the Philippines and 0.90 M.T. (0.45 IR-8 and 0.45 IR-5) from IRRI.

[3] In 1969, less than 0.1 M.T. of IR-20 was imported from IRRI.

[4] In 1970, less than 0.1 M.T. of IR-20 and 0.35 M.T. of IR-22 were imported from IRRI.

[5] IR-8 and IR-262. The breakdown of production by season was:

Crop year	*Yala* (summer)	*Maha* (winter)	*Total*
	Percent		
1968/69	6.6	93.4	100
1969/70	15.4	84.6	100
1970/71	32.1	67.9	100
1971/72	39.4	60.6	100
1972/73	46.9	53.1	100

(Note: the crop year used in this table is different from that used in Sri Lanka. For example, Yala 1970 is combined with Maha 1970/71 here; in Sri Lanka, Maha 1970/71 is combined with Yala 1971.)

[6] In addition to IR-8 and IR-22, the following areas were planted to other improved varieties:

	H Series[a]	*BG Series*[b]	*Other*	*Total*
	Acres			
1968/69	1,020,000	—	17,800[c]	NA
1969/70	1,054,000	—	22,300[c]	NA
1970/71	1,010,850	2,830	NA	NA
1971/72	912,500	102,180	(117,870)[d]	NA
1972/73	512,600	486,948	259,199	1,258,747

[a] Principally H-4; the H series varieties, except for H-9, are considered as the "old" high-yielding varieties.

[b] Principally BG 11-11; the BG series contains the "new" high-yielding varieties.

[c] A-8 and PTB-16 only.

[d] Maha only.

Possibly the BG series should be listed along with IR-8 in the main table but more needs to be known about its genealogy, growth habits, and yields.

REFERENCES

(1) Barker (June 1969).
(2) Barker (October 1970).
(3) Letter from H. L. Dwelly, Acting USAID Representative, American Embassy, Colombo, October 2, 1969 (data supplied by Ministry of Agriculture and Food).
(4) Data supplied by Ministry of Agriculture and Food, Colombo, October 16, 1970 (forwarded by Michael H. Snyder, Assistant USAID Representative, Colombo, October 21, 1970).
(5) Data supplied by the Ministry of Agriculture and Lands, Colombo, December 10, 1970 (forwarded by Snyder, December 14, 1970).
(6) Data supplied by T. B. Subasinghe, Deputy Director for Agricultural Development, the Ministry of Agriculture and Lands, Colombo, December 9, 1971 (forwarded by Snyder, December 13, 1971).
(7) Data supplied by T. B. Subasinghe, *op. cit.*, January 25, 1974 (forwarded by H. Birnbaum, Acting USAID Representative, Colombo, January 28, 1974).

Table 30—Thailand: HYV rice seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested[1]	
	Metric Tons	*Hectares*	*Acres*
1969/70		(5,000)	(12,400)[2] (1)
1970/71		(115,000)	(284,000)[2] (1)
1971/72		(315,000)	(778,000)[2] (1)
1972/73		(350,000)	(865,000)[2] (1)
(1973/74)		[3]	[3] (1)

[1] Unofficial guess of area; official statistics not yet available. Principally RD1. C4-63, RD2, and RD3 never became popular. RD4 and RD5 were coming into use in 1973/74.

[2] The seasonal breakdown was:

	Wet (June-Dec.)	Dry (Feb.-June)	Total
		Percent	
1969/70	–	100.0	100
1970/71	87.0	13.0	100
1971/72	79.4	20.6	100
1972/73	42.9	57.1	100

It is possible that the HYV area in the wet season is dropping as the threat of Tungro virus becomes less and more farmers revert to their old, tall, photoperiod-sensitive varieties. By 1972/73, an estimated 95 percent of the dry season area was planted to HYV's.

[3] An estimated 80,000 ha (198,000 acres) were planted during the 1973/74 wet season. (This estimate has some statistical basis behind it.)

REFERENCE

(1) Letter from Delane Welsch, Department of Agricultural Economics, Kasetsart University, Bangkok, January 14, 1974.

Table 31—Vietnam (South): HYV rice seed imports and area planted or harvested

Crop year	Quantity of seed imported	Area planted or harvested	
	Metric tons	Hectares	Acres
1967/68	45 [1] (1)	500	1,200[7] (1)
1968/69	2,005 [2] (1)	40,500	100,000[8] (6)
1969/70	0.1[3] (2)	201,500	498,000 (6)
1970/71	1.0[4] (3)	502,000	1,240,400 (5)
1971/72	56.0[5] (4)	674,000	1,665,400 (5)
1972/73		835,000	2,063,300 (5)
(1973/74)	[6] (5)		

[1] IR-8; imported in October 1967. This shipment is noted in an AID report (ref. 1) but not in IRRI listings (which cite only shipments of less than 0.1 M.T. of IR-8 and IR-5; ref. 7).

[2] 2,000 M.T. of IR-8, 5 M.T. of IR-5. Barker indicates that the Philippines exported 1,807 M.T. of IR-8 and 205 M.T. of IR-5 to Vietnam (ref. 7). The reason for the difference in varietal composition is not known.

[3] 143 lbs (65 kg) of IR-20 received from IRRI in June 1969.

[4] IR-22 from IRRI, 1970. In addition, less than 0.1 M.T. of IR-20 seed was received from IRRI.

[5] Of this, 55 M.T. were IR-20 imported from the Philippines in March 1971 (50 M.T. were distributed to farmers in flood ravaged provinces; 5 M.T. were registered seed and were distributed for certified seed production) while 1 M.T. of RD1 was imported from Thailand as a possible replacement for IR-5 (known locally as TN-5).

[6] 35 M.T. of certified IR-20 were exported to Cambodia in July 1973.

[7] Area planted. Only about 330 acres were harvested because of poor rains.

[8] The goal was 109,000 acres. Estimates of achievement range from 90 to 100 percent.

REFERENCES

(1) *Rice in South Vietnam,* Spring Review (AID), March 12, 1969 (TOAID A-1357), pp. 2, 8, 15, 16, 17.

(2) Agricultural Production Memo, Rice Series No. 117, Office of Domestic Production, USAID, Saigon, January 6, 1970. Also noted in Department of State Airgram TOAID A-5406 from Saigon, October 31, 1970, p. 5.

(3) Barker (October 1970).

(4) Agricultural Production Memo, Rice Series No. 140, Office of Food and Agriculture, USAID, Saigon, May 25, 1971, pp. 1-5; letter from Ralph W. Clark, Agricultural Production Division, Office of Food and Agriculture, USAID, Saigon, November 20, 1971.

(5) Letter from C. T. Brackney, Agronomy Advisor, Rice, Office of Food and Agriculture, USAID, Saigon, November 7, 1973. The 1970/71 data were based on records of the Rice Service; beginning in 1971/72, data were obtained from the somewhat more conservative Directorate of Agricultural Economics.

(6) William J. C. Logan, "Changes in South Vietnamese Agriculture Raise Farm Production and Profits to New Levels," *Foreign Agriculture,* October 12, 1970, p. 9 (slight adjustments in data in accordance with subsequent discussion with Logan).

(7) Barker (June 1969).

AFRICA

Formal statistical information of HYV rice production in Africa is quite limited, but informal estimates and comments have been provided for 1973 by J. C. Moomaw, Director of Outreach, The International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria.[1] Dr. Moomaw was previously with IRRI and brought small quantities of IR-20 to Nigeria with him in 1970 (IRRI varieties were, however, shipped directly to three African nations as early as 1968; see the last section of this chapter). IITA is acting as an African relay station for IRRI. The West African Rice Development Association (WARDA) is also multiplying some IR-5 and IR-20 seed in Senegal. Some of the early Philippine varieties, particularly IR-8 and C4-63, have been found susceptible to blast in the humid districts of West Africa. Comments on seven nations follow.

GHANA

A substantial area, "probably 3,000 acres (1,200 ha) or more," of IR-20 was planted after it was determined that C4-63 was susceptible to blast.

IVORY COAST

A number of cooperative programs, involving thousands of acres, are underway to improve and expand rice culture. One major effort, financed by the Fond Europeen de Development, is being undertaken in swamp areas in the north; about 70 percent of the area is planted to IR-5 and 30 percent to IR-8.[2] Significant quantitites of these two varieties have also been planted in the Yamassukro area. Moomaw noticed 250 acres (100 ha) in one farm.

LIBERIA

Liberia grows very little paddy rice, but some IR-5 and Tainan 3 has been raised in small and scattered swamp development projects. Perhaps 150 to 200 acres (60 to 80 ha) were planted. A vast upland program of about 2,000 acres (800 ha) in the Foya District is largely planted to a variety called LAC-23; the program is expected to be considerably enlarged in 1974.

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[1] Letters from Dr. Moomaw, October 12 and December 28, 1973.

[2] Letter from M. Rossin, Le Directeur Technique, Societe Pour le Developpement de las Riziculture (SODERIZ), Abidjan, February 22, 1974.

MAURITANIA

A dwarf rice from the People's Republic of China was introduced on a state farm managed by the Chinese at Rosso in February 1971.

NIGERIA

IITA has supplied about 2 M.T. of IR-20 seed multiplied from the stock Moomaw brought. Some plantings (those in the Lake Chad District) failed because of the drought but others (such as on the Jos Plateau in the Eastern states) have done well. Moomaw estimates that perhaps 1,200 to 1,500 acres (500 to 600 ha) of the IRRI varieties were being raised in 1973.

SENEGAL

Substantial areas of IR-8 are thought to be growing where irrigation water is available along the Senegal River. The Nationalist Chinese Extension Station at Gege has promoted 370 to 500 acres (150 to 200 ha) of IR-8. Disease is no problem in the dry climate.

SIERRA LEONE

The country has not moved strongly in the direction of dwarf rices because of disease problems, toxic soil factors, and the heavy plantings of upland rice. Nevertheless, the Nationalist Chinese, before they left in 1972, had a planting of about 150 acres (60 ha) of IR-5 or a Taiwan variety on the Little Scarcies River below Mange. There is also said to be a substantial acreage of HYV's in the Kenema District.

LATIN AMERICA

High-yielding rice varieties, largely of Asian origin, began to be planted in Latin America in substantial quantities in the early 1970's. Fortunately, data have become available which make it possible to provide fairly detailed area estimates for 11 countries.

They were obtained in a different manner than was followed in Asia and will be presented in a different format. The basic reference was the *CIAT Annual Report, 1972* (p. 160) which contains a table providing estimates of the proportion of rice areas planted to HYV's in 1971/72 and 1972/73. Estimates are also included for major varieties. These data, in turn, were combined with estimates of total rice area in each country[3] to give an estimate of the HYV area. Where possible, these figures were sent to American agricultural attaches or USAID food and agriculture officers for checking and further comment. Some data were based entirely on these sources.

For the 11 countries listed, the total HYV area in 1972/73 appears to have been about 1,061,400 acres (429,600 ha).

Although the estimates have been made as carefully as possible, the data are subject to error. Estimates of the proportion of area planted to HYV's, for instance, are subject to revision. And the inclusion of some varieties in the HYV category may be subject to question.

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[3]As reported by the Foreign Agricultural Service of the U.S. Department of Agriculture, December 1973.

Table 32—Estimated area planted to high-yielding rice varieties in Latin America

Country and year	HYV area		HYV as percent of total rice area				
	Hectares	Acres	Total	IR-8	IR-22	CICA-4	Other
Colombia							
1971/72	125,400	309,860	47.3	18.9	10.1	18.3	–
1972/73	165,820	409,740	57.0	20.1	24.3	12.6	–
Costa Rica							
1971/72	24,550	60,665	55.8	55.8	–	–	–
1972/73	29,840	73,730	66.3	23.3	22.8	10.2	10.0
Dominican Republic							
1972/73	10,050	24,830	15.0	–	–	–	15.0[2]
Ecuador					(INIAP-2)	(INIAP-6)	
1971/72	10,400	25,700	13	13	–	–	–
1972/73	17,850	44,110	21	6	3	12	–
El Salvador							
1972/73	11,000	27,150	(100)[3]	–	–	–	(100)[3]
Honduras							
1972/73	170	420	13	–	4[4]	–	9[5]
Mexico[6]					(Navolato A-71)[7]		
1971/72	100,000	247,100	59.2	23.4	0.3	–	35.5[8]
1972/73	95,000	234,700	57.6	18.2	3.0	–	36.4[8]
(1973/74)	(114,000)	(281,700)	(67.1)	(9.7)	(20.6)		(36.8)[8]
Nicaragua							
1971/72	7,020	17,345	39		–[9]–		
1972/73	10,140	25,060[9]	39[9]				
Panama							
1972/73	25,500	63,000	30[10]	–	–	–	–
Peru							
1971/72	26,460	65,380	18	18.0	–	–	–
1972/73	29,200	72,150	22.3	2.3	–	–	20
	(47,200)[11]	(116,600)[11]	(36)[11]				
Venezuela[12]					(IR-22)		
1973	30,000 to 40,000	74,100 to 98,840	26.5 to 35.4	–	17.7 to 22.1	8.8 to 13.3	–

[1] *Programa Nacional de Arroz, Informe Anual de Progreso 1973,* Instituto Colombiano Agropecuario (ICA), Ministerio de Agricultura, Palmira, pp. 1, 3, 4; 1971/72 HYV data provided by the office of Dr. Manuel Rosero, ICA. The total rice area was also obtained from these sources.

[2] The principal improved spring varieties are IR-5, IR-6, IR-64, and Juma 57, Enano 5, Tono Brea 408, and Tono Brea 409. Juma 57 was bred locally by crossing IR-8 with Nilo; about 864 acres were planted in 1972, Enano 5 and TB 408 and 409 are improved local varieties. (Letters from L. R. Fouchs and M. M. de Moya, Office of Agricultural Attache, American Embassy, Santo Domingo, October 11, 1973, and February 22, 1974.) IR-8 was introduced for experimental purposes in December 1965 (see *Comportamiento del IR-8 en la Republica Dominicana,* Secretaria de Estado de Agricultura, 1969, 12 pp.).

[3] The reported varietal breakdown is as follows: Nilo 1, 21 percent; Nira, 14 percent; Seleccion 11 thought to be Nilo 11), 10 percent; Nilo 3, 9 percent; Nilo 48, 9 percent; Nilo 2, 8 percent; and other, 29 percent. Other includes Blue Bonnet, Rexora, Fartuna, Nilo 9, Nilo 10, CICA 4, Dima, and Cebada. Not all of these may be considered high-yielding varieties. (Letter from Donald M. Nelson, Agricultural Attache, American Embassy, San Salvador, October 30, 1973; based on data provided by the Ministry of Agriculture.)

[4] Another report indicates that "knowledgeable people know of no IR-22 planted in Honduras. It is said to be susceptible to blast." (Letter from John C. McDonald, Agricultural Attache, American Embassy, Guatemala City, November 16, 1973.)

[5] Another observer indicates that CICA-4 comprises 5 to 10 percent of the total area, suggesting that it occupies most of the "other" cateogry. (McDonald, citing Harold Koone of USAID, Tegucigalpa.)

[6] Based on estimates by the Institute Nacional de Investigaciones Agricolas (INIA). Provided by Richard A. Smith, Agricultural Attache, American Embassy, Mexico City, January 18, 1974.

[7] Navolato is a sister selection of IR-22.

[8] Sinaloa A-68 (TN-1 x Nahng Mon S-4).

[9] The rice cooperative (CASA), which accounts for about half of the total rice production, reports some 26,100 acres of HYV's; this exceeds the total reported for the country. CASA's HYV area was

divided as follows: IR-100, 40 percent; IR-22, 38 percent; Nilo 1, 10 percent; CICA-4, 8 percent; and others, 45 percent. (Letter from Nelson, *op. cit.*, November 23, 1973.)

[10] Composed of Nilo 1, Nilo 2, and CICA-4. Nilo 1 is the most important (Letter from Raymond A. White, Rural Sector, USAID, Balboa, November 5, 1973; based on information provided by the University of Panama.)

[11] Based on estimates of both total and HYV area reported by the Ministry of Agriculture. Principally Naylamp (CICA-4). (Letter from Paul Ferree, Agricultural Attache, American Embassy, Lima, October 16, 1973.)

[12] Based on estimates reported by Douglas M. Crawford, Agricultural Attache, American Embassy, Caracas, November 6, 1973.

ADDITIONAL SEED IMPORT DATA

Table 33—Imports of high-yielding Philippine and IRRI rice seed by countries where no planted area data are yet available

Country	1967	1968				1969			1970				
	IR-8	IR-8	IR-5	C4-63	C4-113	IR-8	IR-5	C4-113	IR-8	IR-5	IR-20	IR-22	C4-63
	Metric tons												
Asia													
Iran		#											
Iraq						100#							
UAR	100#												
Saudi Arabia		*											
Singapore									#	#			
Turkey		*	*			*							
Africa						*	*		*	*	0.1*	0.7*	
Ghana				2									
Ivory Coast		*	*							*	*	*	
Liberia		1#	1#	1#								0.5*	
		*										#	
Latin America													
Colombia			*									*	
Ecuador			#			2.2#	#						
El Salvador												0.2*	
Nicaragua											*	0.3*	
Panama	10#	10*	#		#	#	#	#			33.5#	2#	33.5#
Venezuela		10#											

From commercial sources in Philippines; where used by itself indicates less than 1.0 metric ton.

*From International Rice Research Institute; where used by itself indicates less than 0.1 metric ton.

Source:

Data provided by Dr. Randolph Barker, IRRI, October 23, 1970.

V SUMMARY OF ESTIMATED AREA DATA

In this chapter, the area data reported in the individual country tables are pulled together in summary form. The chapter basically consists of five tables: the first summarizes the totals by year and is followed by a chart depicting growth in use; the second summarizes the wheat area by country and year; the third does the same for rice; and the fourth and fifth report HYV area as a proportion of total wheat or rice area. Just as the individual country tables covered only non-Communist nations in Asia and North Africa, the summary tables presented here are similarly limited in geographic scope. Also, the area of HYV rice in Latin America, as well as the proportion it represented of total rice, was summarized by country in the previous chapter so will not be repeated here. Furthermore, all the data are rounded and are to be considered only approximate.

A few comments on the data provided in the five tables (Tables 34 through 38) follow.

TOTAL HYV WHEAT AND RICE AREA

The overall area planted to high-yielding wheat and rice varieties in Asia and North Africa continued to expand significantly through 1971/72 and 1972/73 (Table 34). Total wheat and rice area was about 21.5 million hectares (53.2 million acres) in 1970/71, 27.7 million hectares (68.5 million acres) in 1971/72, and 32.5 million hectares (0.2 million acres) in 1972/73.[1] The rate of increase for wheat and rice from 1966/67 was remarkably similar, except for 1968/69 (Figure 3).

Of the total HYV area in 1972/73, about 52 percent was composed of wheat and 48 percent was rice. The total wheat area in 1972/73 was 16.8 million hectares (41.6 million acres) while the rice area was 15.7 million hectares (38.7 million acres). Compared to 1971/72, the 1972/73 wheat area was 19.4 percent higher while the rice area was 16.5 percent higher.[2] About 94 percent of the wheat and all of the HYV rice area reported in this section was in Asia; the remaining 6 percent of the wheat was in North Africa.[3]

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[1] In addition, about 429,600 hectares (1,061,400 acres) of HYV rice were planted in Latin America in 1972/73, excluding Cuba. Details are provided in Table 32 in the previous chapter.

[2] 1972/73 was, because of poor weather, a poor year for rice in Asia. The total rice area in Asia (excluding Communist nations and Japan) was 5 percent less than in 1971/72.

[3] If Latin America, except for Cuba, is included, then over 98 percent of the total HYV rice area was accounted for by Asia.

Table 34—Estimated high-yielding wheat and rice area, Asia and North Africa, 1965/66 to 1972/73[1]

Unit of area and year	Area		
	Wheat	Rice[2]	Total
HECTARES			
1965/66	9,300	49,400	58,700
1966/67	651,100	1,034,300	1,685,400
1967/68	4,123,400	2,605,000	6,728,400
1968/69	8,012,700	4,706,000	12,718,700
1969/70	8,845,100	7,848,800	16,693,900
1970/71	11,344,100	10,201,100	21,545,200
1971/72	14,083,600	13,443,400	27,537,000
1972/73 (Prelim)	16,815,500[3]	15,658,600[4]	32,474,100
ACRES			
1965/66	22,900	122,100	145,000
1966/67	1,608,800	2,555,900	4,164,700
1967/68	10,188,800	6,437,200	16,626,000
1968/69	19,799,700	11,628,000	31,427,700
1969/70	21,856,400	19,394,300	41,250,700
1970/71	28,031,400	25,207,000	53,238,400
1971/72	34,800,500	33,217,900	68,018,500
1972/73 (Prelim)	41,551,100[3]	38,692,000[4]	80,243,100

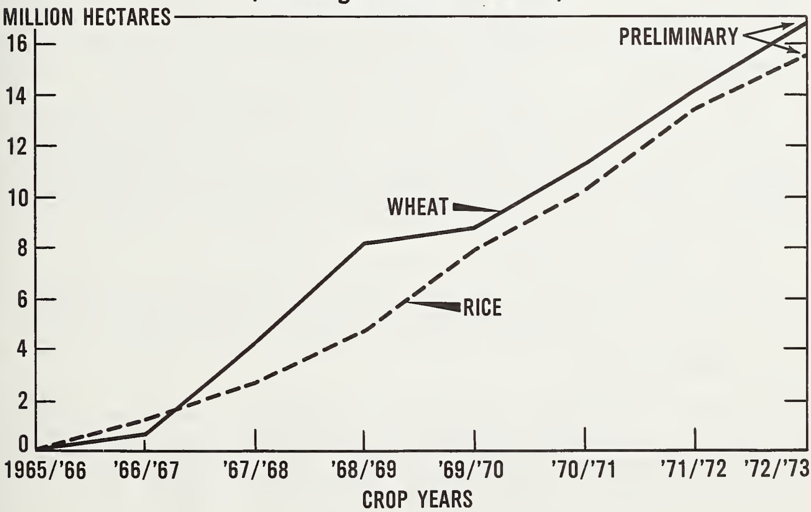
[1] Excludes Communist nations.

[2] Excludes Japan and Taiwan.

[3] Includes Turkey at 1971/72 level.

[4] In addition, about another 429,600 hectares (1,061,400 acres) of rice were planted in Latin America (excluding Cuba).

Figure 3. ESTIMATED HIGH-YIELDING WHEAT AND RICE AREA, ASIA AND NORTH AFRICA, 1965/66 to 1972/73 (Excluding Communist Nations)



In terms of individual countries (Tables 35 and 36), India was by far the leader for both grains. It accounted for the following proportions of total HYV area for Asia and North Africa:

	Wheat	Rice
	Percent	
1970/71	57.1	54.8
1971/72	55.8	55.1
1972/73	60.8	55.2

In the case of wheat in 1972/73, India was followed by Pakistan with 19.9 percent; Turkey, 3.9 percent; Algeria, 3.6 percent; Iraq, 2.7 percent; and Afghanistan, 2.7 percent. India and Pakistan each had over 1 million acres. In the case of rice in 1972/73, India was followed by the Philippines with 11.2 percent; Indonesia, 9.7 percent; Bangladesh, 6.8 percent; South Vietnam, 5.3 percent; and Pakistan, 4.1 percent. The first four countries each had over 1 million acres. Thus, the area of HYV wheat is more highly concentrated in a few countries than is the case for HYV rice.

PROPORTION OF TOTAL AREA DEVOTED TO HYV'S

For analytical purposes, it is often useful to know what proportion of the total wheat or rice area in individual LDC's is planted to the HYV's. Total crop area estimates are relatively easily obtained and will not be reproduced here. But the percentage of total crop area represented by HYV's will be reported. In calculating these proportions, total crop areas as reported by the Foreign Agricultural Service (FAS) of the U.S. Department of Agriculture have been used.[4]

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[4] The FAS data do not entirely agree with area estimates from other sources, so use of other area figures could produce different proportions. The FAS data was obtained from the following sources:

—Wheat: 1965/66 to 1970/71, *Trends in World Grain Production, 1960 to 1972,* FAS M-249, February 1973, pp. 15-17; 1971/72, 1972/73, *World Agricultural Production and Trade* (FAS), March 1974, p. 11. Data for Pakistan and Bangladesh prior to 1970/71 were obtained from A. Gill and G. Hasha of the Economic Research Service, USDA. Area figures for Afghanistan and Nepal came from USAID/Kabul and Kathmandu.

—Rice: 1965/66 to 1970/71, *Review of World Rice Markets and Major Suppliers,* FAS M-246 August 1962, p. 54; 1971/72, FAS Circular FR-2-73, August 1973; 1972/73, *World Agricultural Production and Trade* (FAS) December 1973, p. 27. Data for Pakistan and Bangladesh prior to 1970/71 were also obtained from A. Gill and G. Hasha of ERS.

The FAS data are reported by calendar year. The following procedure was used to convert other data to a calendar year basis: for wheat, 1972 was recorded as 1971/72; for rice, 1972 was assigned to the 1972/73 crop year. This general technique may be in error in some cases, but should not throw the results off greatly except in unusual cases.

Table 35—Estimated area planted to high-yielding varieties of wheat in Asia and North Africa

Country	Unit	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73
ASIA									(Prelim)
1. Afghanistan	Hectares	–	1,800	22,000	122,000	146,000	232,000	255,000	450,000
	Acres	–	4,500	54,400	301,500	360,800	573,200	630,000	1,112,000
2. Bangladesh	Hectares	–	–	–	8,400	9,100	13,500	15,000	21,450
	Acres	–	–		20,800	22,500	33,400	37,000	53,000
3. India	Hectares	3,000	540,900	2,942,000	4,792,700	4,917,600	6,480,000	7,861,400	10,236,800
	Acres	7,400	1,336,600	7,269,700	11,842,800	12,151,400	16,012,000	19,425,500	25,295,200
4. Iran	Hectares	–	–	–	10,000	90,000	250,000	277,000	298,000
	Acres	–	–	–	25,000	222,400	617,750	684,500	736,400
5. Iraq	Hectares	–	–	6,400	41,700	195,200	125,000	950,000	457,000
	Acres	–	–	15,800	103,000	482,400	309,000	2,347,500	1,129,200
6. Jordan	Hectares	–		–	90	100	120	140	150
	Acres	–		–	230	250	300	350	380
7. Lebanon	Hectares	–	–	50	400	2,500	7,000	12,000	20,000
	Acres	–		120	1,000	6,200	17,300	29,700	49,400
8. Nepal	Hectares	1,400	6,600	24,800	53,800	75,500	98,200	115,900	170,300
	Acres	3,500	16,200	61,300	132,900	186,600	242,700	286,450	420,700
9. Pakistan	Hectares	4,900	101,200	957,100	2,387,700	2,681,500	3,128,500	3,286,200	3,338,800
	Acres	12,000	250,000	2,365,000	5,900,000	6,626,000	7,730,000	8,120,000	8,250,000
10. Syria	Hectares	–	–	–	–	–	38,000	75,000	180,000
	Acres	–	–	–	–	–	94,000	185,300	444,800
11. Turkey	Hectares	–	600	170,000	579,000	623,000	640,000	650,000	(650,000)[1]
	Acres	–	1,500	420,000	1,430,700	1,539,400	1,581,400	1,606,200	(1,606,200)[1]
Subtotal	Hectares	9,300	651,100	4,122,400	7,995,800	8,740,500	11,012,100	13,497,600	15,822,500
	Acres	22,900	1,608,800	10,186,300	19,757,900	21,597,900	27,211,000	33,352,500	39,097,400
AFRICA									
1. Algeria	Hectares	–	–	–	–	5,100	140,000	320,000	600,000
	Acres	–	–	–	–	12,600	346,000	790,700	1,482,600
2. Morocco [2]	Hectares	–	–	200	4,900	46,500	90,000	206,000	294,000
	Acres	–	–	500	12,100	114,900	222,400	509,000	726,500
3. Tunisia	Hectares	–	–	800	12,000	53,000	102,000	60,000	99,000
	Acres	–	–	2,000	29,700	131,000	252,000	148,300	244,600
Subtotal	Hectares	–	–	1,000	16,900	104,600	332,000	586,000	993,000
	Acres	–	–	2,500	41,800	258,500	820,400	1,448,000	2,453,700
Total Asia and Africa	Hectares	9,300	651,100	4,123,400	8,012,700	8,845,100	11,344,100	14,083,600	16,815,500
	Acres	22,900	1,608,800	10,188,800	19,799,700	21,856,400	28,031,400	34,800,500	41,551,100

[1] 1971/72 area.
[2] Unofficial estimate.

Table 36—Estimated area planted to high-yielding varieties of rice in Asia

Country	Unit	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73
ASIA									(Prelim.)
1. Bangladesh	Hectares	–	200	67,200	152,200	263,900	460,100	623,600	1,069,600
	Acres	–	500	166,000	376,000	652,000	1,137,000	1,541,000	2,643,000
2. Burma	Hectares	–	–	3,400	166,900	143,000	190,900	185,100	199,200
	Acres	–		8,500	412,400	353,300	471,800	457,300	492,200
3. India	Hectares	7,100	888,400	1,785,000	2,681,000	4,343,500	5,589,200	7,411,400	8,639,100
	Acres	17,650	2,195,200	4,410,700	6,624,800	10,732,700	13,811,000	18,313,600	21,347,200
4. Indonesia	Hectares	–	–	–	198,000	826,000	913,000	1,338,000	1,521,000
	Acres	–	–	–	489,000	2,041,000	2,256,000	3,306,000	3,758,000
5. Korea	Hectares	–	–	–	–	–	–	2,700	187,000
(South)	Acres	–	–	–	–	–	–	6,700	462,000
6. Laos	Hectares	–	360	1,200	2,000	2,000	53,600	30,000	50,000
	Acres	–	900	3,000	5,000	5,000	132,500	74,100	123,600
7. Malaysia	Hectares	42,300	62,700	90,700	96,100	132,400	164,600	196,900	217,300
	Acres	104,450	155,000	224,200	237,500	327,100	406,600	486,500	537,000
8. Nepal	Hectares	–	–	–	42,500	49,800	67,800	81,600	177,300
	Acres	–	–	–	105,100	123,000	167,600	201,700	438,000
9. Pakistan	Hectares	–	80	4,000	308,000	501,400	550,400	728,500	643,500
	Acres	–	200	10,000	761,000	1,239,000	1,360,000	1,800,000	1,590,000
10. Philippines	Hectares	–	82,600	653,000	1,012,800[1]	1,354,000	1,565,000	1,827,000	1,752,000[1]
	Acres	–	204,100	1,613,600	2,500,000[1]	3,345,700	3,867,100	4,514,500	4,329,200[1]
11. Sri Lanka	Hectares	–	–	–	7,000	26,300	29,500	29,600	17,600
	Acres	–	–	–	17,200	65,100	73,000	73,100	43,500
12. Thailand[1]	Hectares	–		–	–	5,000	115,000	315,000	350,000
	Acres	–	–	–	–	12,400	284,000	778,000	865,000
13. Vietnam	Hectares	–	–	500	40,500	201,500	502,000	674,000	835,000
(South)	Acres	–	–	1,200	100,000	498,000	1,240,400	1,665,400	2,063,300
Total Asia	Hectares	49,400	1,034,300	2,605,000	4,706,000	7,848,800	10,201,100	13,443,400	15,658,600
(rounded)	Acres	122,100	2,555,900	6,437,200	11,628,000	19,394,300	25,207,000	33,217,900	38,692,000

[1] Unofficial estimate.

The proportion of wheat or rice area planted to HYV's varied widely in 1972/73 (Tables 37, 38). The highest wheat percentages were attained in Nepal (66 percent), followed by Pakistan (56 percent, a slight drop from 1971/72), India (51.5 percent), and Lebanon (31 percent). The highest rice proportion was in the Philippines (56 percent), followed by Pakistan (43 percent, down from 1971/72), Malaysia (38 percent), South Vietnam (32 percent), and India (25 percent).[5] For Asia as whole in 1972/73 (excluding Communist nations, Japan, and Israel), HYV's accounted for nearly 35 percent of the total wheat area and 20 percent of the total rice area.

Over time, several different patterns have emerged. Several of the leading countries show constant or continuing rates of increase (Afghanistan, India, Nepal, and Algeria for wheat; India, Indonesia, Malaysia, and Vietnam for rice). Pakistan, on the other hand, showed a decline for both wheat and rice in 1972/73; in the case of rice this may have been in part due to civil matters and price policies.

Countries with current high levels of adoption are likely to face slower rates of expansion in the future. Most new technologies show an S-shaped adoption curve; that is, the rate of adoption starts slowly, then picks up speed, and finally drops off as the innovation is widely used. Some nations are probably well along the adoption curve or approaching the top.

For most major countries, moreover, the top of the curve for HYV's may be considerably below 100 percent[6]. Several supply and demand factors constrain adoption. On the supply side, we have noted (1) that the present HYV's are not suitable for all soil and climate conditions and, (2) that they require seeds and inputs which are either not available or not utilized by every farmer. The fertilizer shortage which emerged in 1973 and 1974 is likely to further slow the rate of adoption. On the demand side, the current HYV's do not meet all consumer requirements. In many areas, for example, there are long-established tastes for certain types and kinds of grains which are not satisfied by the present HYV's. Because of these and other factors, the HYV's are unlikely to completely replace traditional varieties in most major areas in the near future.

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[5] Relatively high percentages were also found in several Latin American nations (see Table 32 in the previous chapter).

[6] The only exceptions to date are Mexico (wheat), and the relatively small nations of Cuba (rice) and El Salvador (rice). A statistical quirk which will keep the percentage down in a few countries, such as Indonesia, is that the HYV figures reported refer only to government program areas; private plantings are not included.

Table 37—Proportion of total wheat area planted to high-yielding varieties

Country	Crop year							
	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73
	Percent							
ASIA								
Afghanistan	—	negl.	1.0	5.2	6.2	10.7	13.3	18.4
Bangladesh	—	—	—	7.2	7.6	11.3	11.8	17.7
India	negl.	4.2	19.6	30.0	29.6	35.5	41.1	51.5
Iran	—	—	—	0.2	2.1	6.3	6.4	6.9
Iraq	—	—	0.3	2.0	9.6	9.0	45.2	22.9
Jordan	—	—	—	4.0	4.1	4.0	5.0	10.0
Lebanon	—	—	negl.	0.7	4.1	11.7	18.8	31.3
Nepal	1.2	5.2	12.9	25.9	33.5	43.0	50.6	65.8
Pakistan	0.1	1.9	16.0	38.0	43.0	52.3	56.7	55.9
Syria	—	—	—	—	—	4.3	6.8	21.2
Turkey	—	negl.	2.1	7.0	7.6	7.8	8.0	8.0[1]
AFRICA								
Algeria	—	—	—	—	2.2	6.7	14.5	27.9
Morocco[2]	—	—	negl.	0.3	2.5	4.8	10.0	13.4
Tunisia	—	—	0.1	1.8	7.1	10.7	6.0	10.4

[1] Based on 1971/72 HYV area.
[2] Based on unofficial estimates of HYV area.

Table 38—Proportion of total rice area planted to high-yielding varieties

Country	Crop year							
	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73
	Percent							
ASIA								
Bangladesh	—	negl.	0.7	1.6	2.6	4.6	6.7	11.1
Burma	—	—	negl.	3.3	2.9	3.6	3.6	4.2
India	negl.	2.5	4.9	7.3	11.5	14.9	19.9	24.7
Indonesia	—	—	—	2.4	10.3	11.2	15.9	18.0
Korea (South)	—	—	—	—	—	—	0.2	15.6
Laos	—	negl.	0.2	0.3	0.2	6.0	3.3	5.5
Malaysia	10.0	14.7	20.6	20.1	26.4	30.9	35.7	38.0
Nepal	—	—	—	3.7	4.4	5.8	6.3	14.8
Pakistan	—	negl.	0.3	19.8	29.9	36.6	50.0	43.4
Philippines	—	2.7	19.8	30.4[1]	43.5	50.3	56.3	56.3[1]
Sri Lanka	—	—	—	1.0	3.9	4.4	4.2	2.5
Thailand[1]	—	—	—	—	0.1	1.5	4.0	4.9
Vietnam (South)	—	—	negl.	1.6	8.3	19.9	25.9	32.1

[1] Based on unofficial estimates of HYV area.

VI. APPENDIX: RICE IMPROVEMENT IN COMMUNIST NATIONS

PEOPLE'S REPUBLIC OF CHINA

The People's Republic of China has long been the world's largest rice producer. Accordingly, it has an extended history of rice improvement. As with other countries, much was simply farmers selecting improved varieties which were then used locally. The major characteristics of this process were outlined in Chapter II.

Both indica and japonica rices are found in China. Most varieties grown in southern China have traditionally been indicas. Both varieties have been reported growing in the area bordering the Yangtze River in central China.[1]

Irrigation and fertilization of rice have long been practiced in China.[2] Through most of history, the fertilizers were organic products such as compost, green manures, oil meals, fish cakes, and night soil. The development of quick-acting chemical fertilizers promised a much sharper boost for varieties which could respond to their application and yet not lodge.[3] Such fertilizers, however, were not widely adopted until the 1960's.[4]

Stalk strength is a particularly important factor in the southern portions of China, especially in Kwangtung Province, because the early crop matures during the first part of the typhoon season. According to the Kwangtung Academy of Agricultural Science, six strains of dwarf rice were successfully developed between 1959 and 1963.[5] Another account says the parent of the most widely used early rice variety was found by two peasants in 1956 in an

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[1] T. H. Shen, *Agricultural Resources of China,* Cornell University Press, 1951, p. 197.

[2] See Dwight H. Perkings, *Agricultural Development in China, 1368-1968,* Aldine, Chicago, 1969, pp. 60-76.

[3] In Japan, increasing application of commercial fertilizer (fishmeal, soybean cakes) in the late 1800's and chemical fertilizer in the early 1900's led to an early interest in the development of such varieities. One of the first was selected in 1877. (Takane Matsuo, *Rice Culture in Japan,* Yokendo Ltd., Tokyo, 1955, p. 13.)

[4] Perkins, *op. cit.*, pp. 60-76.

[5] It is reported that at least some of the short-stalk strains were developed in eastern Kwangtung, a well-known high-yield rice area, from a parent species native to Fukien Province. Similarly, to the immediate north in Kiangsi Province, a short-stemmed rice (Bantam Nan No. 4) was introduced from Fukien in early 1964. Dee-geo-woo-gen, one of the parents of TN-1 and IR-8, is thought to have come from Fukien.

eastern Kwangtung field which was otherwise flattened by a typhoon; the first promising cross breed was obtained in 1959.[6] Distribution of a dwarf "Nanteh" variety (I-geo Nan-teh) began in 1961.[7]

Large-scale dissemination of dwarf, high-yielding varieties began in 1964. By 1965, a total of about 4.3 million hectares (10.6 million acres) were reportedly planted. This was 13 percent of the total rice area in the country. The main varieties were: Nung-k'en 58 (26 percent of the total), Chen-chu-ai (17 percent), Ai-chiao-nan-t'e (17 percent), and others (40 percent). Adoption of these varieties (with Chiang-nan-ai substituting for Nung-k'en 58) was particularly rapid in Kwangtung. By 1965, about 1.5 million hectares (3.7 million acres) were reportedly sown; this accounted for two thirds of the early crop. In Kiangsu, about 0.63 million hectares (1.6 million acres) were planted to Nung-k'en 58 in 1965. High-yielding varieties were also heavily planted in Fukien and Hunan provinces.[8]

The subsequent role of these particular varieties, and the area planted to them, is not clearly known. Some accounts indicated that they continued to be extensively planted in Kwangtung in the late 1960's.[9] Several radio accounts and visitors in 1969 mentioned dwarf, high-yielding varieties.[10] Record rice yields reported in China in 1969 were attributed to the introduction of new varieties.[11] By 1970, dwarf varieties were reportedly extensively used in all early rice producing provinces (the area of early rice accounts for about one quarter of the total rice output in China).[12]

It has been a tantalizing question whether the IRRI varieties have played any role in recent Chinese developments. The Chinese have said nothing and Western news accounts have been mixed. Several reporters have pointed out the similarities between the IRRI and Chinese varieties, but have gone no further. Only one writer is known to have actually said that IR-8 was being used in China;[13] he indicated that the Chinese began their first experiments

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[6] Foreign Agricultural Service Report No. HK 2036 from Hong Kong, June 2, 1972, p. 4.

[7] Based on comments provided by Yueh Tung, Office of the Agricultural Officer, American Consulate General, Hong Kong, September 23, 1970.

[8] Benedict Stavis, *China's Green Revolution,* Cornell University, East Asia Papers, No. 2, January 1974, pp. 20-27 (I am indebted to Randolph Barker for bringing this report to my attention). Another source places the dwarf area in Kwangtung at nearly 1 million acres in 1964 (or about half the total rice area); by 1965, the dwarf area represented more than 80 percent of the total (Tung, *op. cit.*).

[9] Stavis, *op. cit.*, p. 25.

[10] Tillman Durdin, "Chinese Report New Rice Strain," *New York Times,* October 26, 1969; "Two Big Harvests Reported in China," *New York Times,* November 19, 1969.

[11] "Two Big. . . ," *op. cit.*

[12] Tung, *op. cit.*

[13] One other article stated that the Chinese were using the varieties, but the author indicated that a typographical error was made in composing and a critical "not" was left out (Lee Lescaze, "Fat Grain Harvest Rewards Red China's Agricultural Push," *Washington Post,* August 2, 1970; letter from Lescaze, Hong Kong, September 7, 1970).

with the seed in 1968, and then placed orders for seed through proxies in Nepal and Pakistan for spring planting in 1970.[14]

In any case, in late November 1973, Philippines President Marcos presented 1 M.T. of IR-20 and one sack of IR-26 to a visiting Chinese trade delegation. The gift was reportedly in response to a request from Premier Chou En-Lai. The delegation also visited IRRI. It was unofficially understood that China previously had seed of IR-8, IR-20, and IR-22.[15]

With the lowering of the barriers between China and the outside world, perhaps more will be learned in the future of their use of high-yielding varieties.

NORTH VIETNAM

Short-season rice strains were introduced in the mountain areas of North Vietnam in 1948. They were classified as a *spring* rice (planted in the spring and harvested in the summer) and their short growing period made it possible to plant them after the traditional fall crop (10-month rice). By 1954, some 5,000 hectares (12,400 acres) of spring rice were planted in the mountain regions.

Beginning in 1957, steps were taken to introduce spring rice into the midlands and delta areas where the traditional 5th month rice (*chiem*) was not well suited. Early efforts were not very successful and, by 1965, the total spring rice area in North Vietnam had dropped to 3,700 hectares (9,100 acres). Thereafter, however, appropriate cultural methods were developed and the area of spring rice expanded sharply:[16]

	Hectares	*Acres*
1966	23,700	58,550
1967	25,050	61,900
1968	34,500	85,250
1969	63,250	156,250
1970	103,650	256,100
1971	540,000	1,334,300
1972	650,000	1,606,150

[14] Richard Hughes, "China Samples the Rockefeller Rice," *London Sunday Times,* February 15, 1970 (reprinted as "Superior Rice Strain is Sold to Red China," *Chicago Tribune,* May 6, 1970). Hughes subsequently indicated (letter, September 21, 1970) that he had confirmed the report with a contact in Peking.

[15] "China–IRRI Rice Research," *Times Journal,* Manila, December 1, 1973, pp. 1, 10.

[16] "Spring Rice," *Viet Nam Courier,* Hano (in English), October 1972, p. 19. Other details are provided in "Spring Rice Has Good Prospects in Vietnam," *Khoa Hoc Thuong Thuc,* Hanoi (in Vietnamese), February and March 1970 (JPRS 50693, June 9, 1970).

While the early spring varieties had a short growing season, they were not classified as high-yielding. Reportedly, *new strains* with short stems and short growth duration were "created" in 1966-1967 "after long and patient agronomical researches."[17] During the 1969/70 winter-spring season, about 18.5 percent of the spring rice area was planted to new varieties. By 1970/71, this had increased to 58 percent.[18] By the 1971/72 season, the proportion was placed at 65 to 70 percent.[19] The subsequent level of use is thought to have remained in this range. Since the spring crop now accounts for about 40 percent of the annual crop, this means that from 26 to 28 percent of the total rice area is planted to the improved varieties. In addition, some (less than 15 percent) of the 10-month crop is sown to improved varieties. Altogether, then, new varieties represent perhaps 1/3 of the total rice area.

Two of the most important improved varieties are Nong Nghiep (Agriculture) 5 and Nong Nghiep (Agriculture) 8. As of September 1969, the two were reported "growing experimentally over large areas."[20] A subsequent newspaper account indicated that emphasis was being placed on IR-8; the seed was allegedly obtained "through Hong Kong and elsewhere."[21] In December 1972, Nong Nghiep 8 was reported to be the predominant spring variety.[22] Both it and Non Nghiep 5 also appear to be the principal new varieties used during the 10-month crop.[23] A new variety, A2, is "treated, selected, and nurtured from the IR-8 variety." A2, in turn, is also one of the parents of A3 and A4.[24] IR-5 and IR-8, therefore, appear to have been of considerable significance in North Vietnam.

CUBA

IR-8 rice is widely planted in Cuba and is evidently doing quite well. Of 256,700 acres of rice planted in the "spring campaign" as of late May 1970, 91

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[17] *Ibid.*, p. 20. Varieties mentioned were Tran Chau No. 2 and No. 4.

[18] "New Varieties, New Productivity," *Nhan Dan*, Hanoi (in Vietnamese), February 22, 1972, p. 2 (JPRS, 55745, April 18, 1972).

[19] "Fertilizing Rice," *Nhan Dan*. March 20, 1972, p. 2 (JPRS, 55894, May 4, 1972); "Develop Winter-Spring Production," *Nhan Dan*, March 22, 1972, pp. 1, 4 (FBIS, April 5, 1972).

[20] Nguyen Van Luat, "Prospects for Short-Term Rice in Vietnamese Agriculture," *To Quoc*, Hanoi, September 1969, pp. 24-26 (JPRS, 49482, December 19, 1969).

[21] George McArthur, "N. Vietnam Reaping Record Rice Crop," *The Washington Post*, August 19, 1971, p. F2.

[22] "Seeds and Seedlings," *Nhan Dan*, December 18, 1972, pp. 1, 4 (JPRS, 58128, February 1, 1973).

[23] "Establishing the Correct Allocation of 10th Month Rice," *Nhan Dan*, May 22, 1973, p. 2 (JPRS, 59449, July 6, 1973).

[24] "Scientific and Technical Activities News Column," *Tap Chi Hoat Dong Khoa Hoc*, Hanoi, December 1972, pp. 42-43 (JPRS, 58335, February 27, 1973). This is the first direct Vietnamese reference to IR-8 observed.

percent was reportedly IR-8.[25] Sinaloa A68, an IRRI selection from Mexico (see p. 18), is also grown.

Details for some of the leading regions follow. In the Jibaro area, about 30,000 acres (out of a total of 40,000) were sown to IR-8 in the spring of 1969.[26] During the same season, IR-8 was "used in most of the planting" (which totaled 83,500 acres) in Oriente Province;[27] similarly, in 1970, a good share of the rice fields in the Oriente were planted to the variety IR-8 from the Philippines.[28] During the 1969/70 season, 66,400 acres were planted to IR-8 and 2,300 acres to IR-160 in Matanzas.[29]

It appears that Cuba originally obtained 1 kilogram of IR-8 seed from Mexico and did the multiplication themselves.[30] A Cuban newspaper account in December 1968 stated that the seed was obtained after much difficulty.[31] Two Cuban officials visited IRRI in March 1969 and obtained small seed samples of 26 experimental lines.[32] Production of certified seed was scheduled to begin during the winter of 1970/71.

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[25] "The Spring Campaign Reaches 7,663 Caballerias of Rice," *Granma* (Havana, in Spanish), June 1, 1970.

[26] Aldo Isidron del Valle, "Rice Production to Increase in Jibaro Area," *Granma,* May 13, 1969, p. 5.

[27] Lenzano Paneque, "Oriente Rice Harvest," *Granma,* October 2, 1969, p. 1.

[28] Daniel Torres, "Rice in the Economic Program of Oriente Province," Havana Radio, January 1, 1970 (JPRS 49647, January 20, 1970).

[29] Juan Varela Perez, "How is the Rice Plan in Matanzas Going?" *Granma,* January 5, 1970.

[30] Letter from D. S. Athwal, Assistant Director, The International Rice Research Institute, May 21, 1971 (based on comments by Dr. R. F. Chandler).

[31] Rene Camacho Albert, "Rice Plan, Self Sufficiency in 1971 in Oriente," *Granma,* December 21, 1968, p. 5.

[32] Athwal, *op. cit.*

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